



DEPARTMENT OF AGRICULTURE AND
WATER SUPPLY

ADMINISTRATION: HOUSE OF ASSEMBLY

ANNUAL REPORT

1 April 1987 to 31 March 1988



REPUBLIC OF SOUTH AFRICA

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ANNUAL REPORT

of the

**Superintendent-General of the Department of
Agriculture and Water Supply
for the period
1 April 1987 to 31 March 1988**

Published by Authority

Price: (GST excluded)

Local R7,10

Abroad R8,90

Post Free

RP42—1989

*Published by the Department of Agriculture and Water Supply and obtainable from the Directorate of Agricultural Information, Private Bag
X144, Pretoria 0001*

Printed by Cape & Transvaal Printers (Pty) Ltd, Cape Town, for the Government Printer, Pretoria, Tel (012) 323-9731 X267

1989

ISBN 0-621-12078-2

**Report of the Superintendent-General of the Department of
Agriculture and Water Supply
for the period
1 April 1987 to 31 March 1988**

THE HONOURABLE THE MINISTER OF AGRICULTURE,
PRETORIA

Sir,

I have the honour to submit herewith the Annual Report of the Department.

*Dr A.J. Heyns
Superintendent-General of the Department of Agriculture and Water Supply*

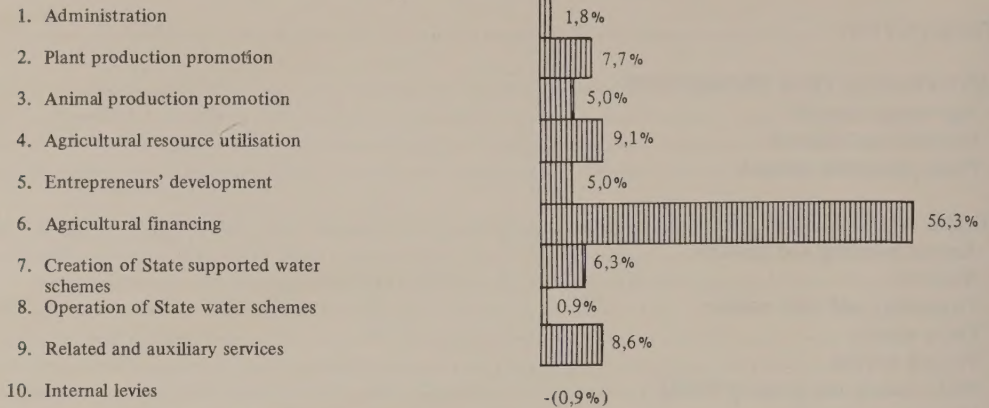
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EXPENDITURE: 1 APRIL 1987 TO 31 MARCH 1988

TOTAL EXPENDITURE

R598,2 million

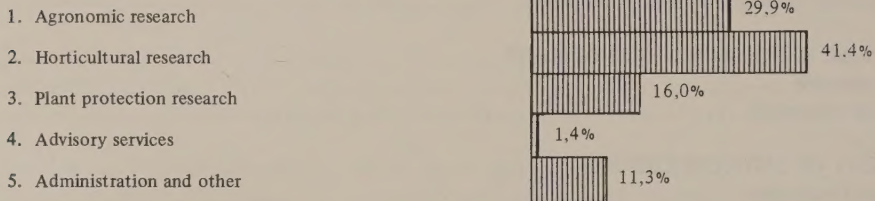


1. ADMINISTRATION (HEAD OFFICE)

R11,0 million

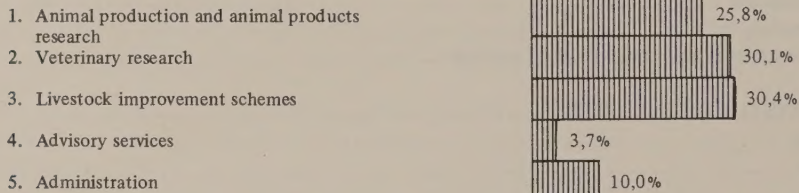
2. PLANT PRODUCTION PROMOTION

R46,3 million



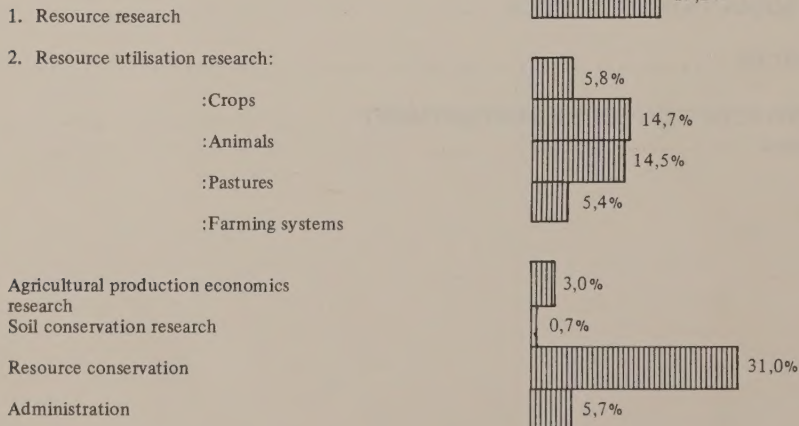
3. ANIMAL PRODUCTION PROMOTION

R29,8 million



4. AGRICULTURAL RESOURCE UTILISATION

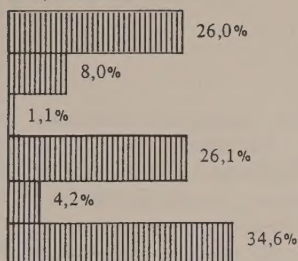
R54,9 million



5. ENTREPRENEURS' DEVELOPMENT

1. Extension services
2. Advisory services
3. Services to other institutions
4. Formal training
5. Agricultural engineering services
6. Administration

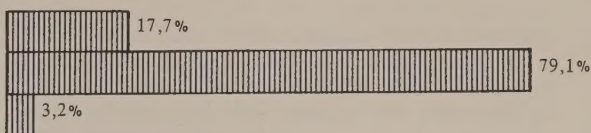
R29,8 million



6. AGRICULTURAL FINANCING

1. Agricultural credit account
2. Subsidies
3. Administration and other

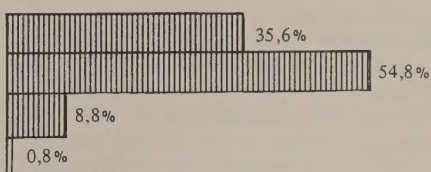
R337,0 million



7. CREATION OF STATE SUPPORTED WATER SCHEMES

1. Construction of State supported water schemes
2. Water drilling services
3. Professional regional services
4. Administration

R37,9 million



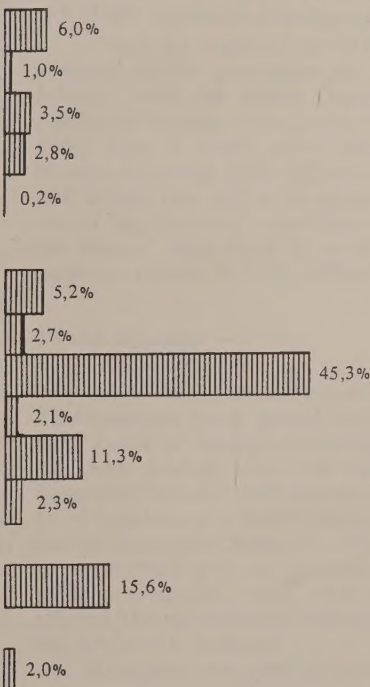
8. OPERATION OF STATE WATER SCHEMES

R5,4 million

9. RELATED AND AUXILIARY SERVICES

R51,6 million

1. Botanical research
2. Molecular biological research
3. Biometric and datametric services
4. Payment to universities and others (research)
5. Contributions in respect of international and national symposia and congresses
6. Development of State agricultural land
7. Chemical services
8. Minor works
9. Maintenance services
10. In-service training
11. Agricultural information services
12. Liaison services
13. Emergency assistance
14. Job creation
15. Groot Constantia-Government Estate
16. Administration and other



10. INTERNAL LEVY

-(R5,5) million

INTRODUCTION

The drought which drastically determined the weals and woes of the farming community over the past few years put the emphasis on financial assistance during the year under review. The pressure of this on the state coffers was aggravated when disaster floods ravished Natal, parts of the Free State and the Northern Cape.

Extensive financial assistance became essential for various reasons, among others to prevent large-scale disruption of the economic and social structure in rural areas. It is obvious that the restructuring of agriculture and attainment of the objectives of the White Paper would be influenced by these circumstances.

Financing

Financing of the agricultural industry is a cardinal facet in the pursuit of optimum production and development. Agricultural financing is via the Land Bank which falls under the Minister of Finance, commercial banks and other private financial institutions, including agricultural co-operatives.

There are also funds that are administered by the Department of Agriculture and Water Supply under the Agricultural Credit Act of 1966. While funding from other institutions is aimed at supplying capital to the more wealthy farmers, funds under the Agricultural Credit Act are meant to assist less well-off farmers with land purchases and means of production loans and to give financial assistance to farmers under exceptional circumstances.

Drought assistance

While some of the assistance measures to farming are of an ongoing nature, natural disasters such as the drought of recent years, or the other extreme - the floods of the past year - mean that the government of necessity has to give comprehensive assistance to the farming industry.

An example is a special assistance scheme (the old Phase scheme) that was introduced for stockfarmers in disaster drought areas as early as 1978. This involved a loan and/or subsidy and a rebate on the transport of stockfeed and licks. The purpose of this scheme was to help farmers to ensure that their livestock survived the drought. As the drought continued, the government adjusted its aid and the Phase scheme was extended in due course. With the continuing drought, however, the veld had no chance to recover. Certain farmers also practised pirate cropping while still benefiting from the assistance schemes. The result was that a new livestock grazing scheme was introduced on a trial basis in the Transvaal bushveld in 1983. This assistance scheme greatly benefited the

conservation-conscious farmer and also involved compulsory reduction of livestock by at least one-third of the official grazing capacity of a farm.

Where livestock were reduced by more than a third, even greater financial benefit was derived. This reduced the load on the agricultural resources and the veld recovered much more rapidly after good rains.

Large parts of the summer rainfall cropping areas went through extremely difficult times as a result of the protracted drought. Some farmers in these affected areas had yields of only about 30% of the normal average yield.

In collaboration with the South African Agricultural Union a scheme was devised that would amount to a one-off input subsidy equivalent to a maximum of R100 per hectare to a maximum of 400 ha under dryland crops per qualifying farmer for the 1987/88 production season. This subsidy was not paid to farmers, but to creditors to settle production debts of the 1987/88 season.

In addition an interest subsidy equivalent to 10 percentage points of the Land Bank's interest rate on cash credit loan was paid to agricultural co-operatives in respect of farmers' carry-over debts for the 1988/89 production season. Production loans of R75 000 per farmer were also made available.

From an amount of R120 million made available by the government for the scheme, 3 480 farmers could be given financial support. The number of farmers aided in this way is considerably higher than it would have been possible to help through the initial R120 million since the amount of R18 million that had to be repaid to the State - as one of the creditors - was also ploughed back into the scheme. This made it possible to extend the assistance scheme to R138 million.

Flood disaster

Two major floods devastated the country this year. This disrupted many people, there was millions of rand worth of damage and irreparable loss of soil that was washed away. In Natal the flood in September/October 1987 caused the entire province to be proclaimed a flood-ravished area. The floods that hit the central interior in February/March 1988 left agriculture with an estimated damage of R350 million. Irrigation areas were particularly badly affected and an estimated 3 400 ha of irrigation land was irreparably damaged.

Assistance was given to farmers under various schemes. This money was in the form of loans and subsidies for the re-establishment of crops and the repair of soil and water conservation works. The full extent of the assistance and the financial implications for the state will only be known in the coming financial year.

Conversion of marginal croplands

Despite the extensive drought assistance measures, it was clear that such measures alone will no longer be enough to intercept the deteriorating financial position of many agricultural producers in the summer rainfall cropping areas.

It is against this background and in the full realisation of the important role which the agricultural industry has to fulfil in the production of essential food and raw materials and the maintenance of the rural economic community that the State President instructed the Economic Advisory Council to investigate the problems of agriculture and suggest steps for the restructuring thereof.

One of the recommended measures was the encouragement of structural adjustments in farming to promote optimum resource use and market-orientated agricultural production. The importance of market-orientated production was re-emphasised because the export potential for South African summer grains and oilseeds had declined drastically and also because factors such as internal price subsidies, export subsidies and unloading on world markets will remain practical realities in the foreseeable future. It was clear that these factors, together with international inflationary differential rapidly destroyed the export possibilities of South African summer grains and oilseeds at a rate to which producers could not adjust their production structures downwards in good time.

Because of the rigid nature of the agricultural production structure in terms of product-directed planting and harvesting implements and the debt load of agricultural producers in the summer rainfall cropping areas, production adjustment, in these difficult times, is very difficult and risky without financial support. Add to this the fact that the most urgent structural adjustment - the incorporation and stabilisation of the livestock factor - would result in further cash-flow problems for the farmer in the early stages.

It was therefore necessary to give producers an incentive according to which structural adjustments could take place more rapidly with a view to the withdrawal of marginal lands so that the livestock branch could be incorporated and/or expanded to bring greater stability to the enterprise. Moreover, it could also help to relieve pressure on the natural veld grazing and promote more efficient feed supplies to the livestock industry.

With this end in view the land conversion scheme was announced on 1 October 1987 to withdraw 1 million ha marginal lands from cash-crop production within a period of 6 years. The scheme was introduced for the entire country, but initially priority was given to the recognised dryland summer cropping areas. The following targets were set:

1987/88	100 000 ha
1988/89	150 000 ha
1989/90	200 000 ha
1990/91	250 000 ha
1991/92	250 000 ha
1992/93	50 000 ha

To encourage participation in the scheme and to supplement cash flow during the conversion from cash-crop lands to perennial low-cost pastures, the producer received R90/ha for establishment costs and a further R50/ha for 4 years (based on the lease value of the lands). A total, therefore, of R140/ha in the first year and R50/ha for a further 3 years. The producer is contractually bound for a period of 6 years during which the pasture must be maintained.

After one season it appears that producers are very interested in the scheme and by the end of September 1988, 1401 producers had applied for conversion of 113 669 ha. Of this only 38% has been successfully established, but it is expected that most of the land will only be established in the 1988/89 season.

If the efforts are successful, it could herald a new era of greater stability for the agricultural industries where in the past producers relied too heavily on cash crops with the concomitant risk and losses from crop failures.

Agricultural production

Mainly as a result of drought conditions the volume of agricultural production has remained more or less static over the past few years.

In the case of crop production and to a lesser extent animal production, there was even a decline, while horticultural production increased.

Despite this downward trend individual industries such as the maize industry and now also the wheat industry are experiencing surplus production and marketing problems.

On the other hand the general income position of farming has improved over the past few years. This can be attributed to higher prices paid for animal and horticultural products, but producers also succeeded in reducing production costs. The prices of horticultural and animal products increased substantially while there was a drop in the price of agronomic products.

This price trend is also reflected in the contribution of the industries to the gross value of agricultural production which, for animal production, increased from 36 to about 43% over the past 10 years, and for horticulture from 15 to 19%. In contrast, the contribution of agronomic production declined from 49% to 38%. The fact that the relative contribution of field crops has decreased, does not, however, belittle the important role still played by the grain industries in supplying the basic food requirements of the population. They will continue to play this role as the population increases. Agriculture, moreover, is practised under uncertain conditions and experience has taught us that surpluses can easily change into shortfalls.

For balanced farming development and optimum agricultural production, it is however important for producers to be familiar with

consumer trends and the influence thereof on market prospects and to adjust their production systems accordingly. Marketing institutions such as

marketing boards also should concentrate increasingly on informing the production sectors continuously on the market situation.

PLANT PRODUCTION PROMOTION

AGRONOMY RESEARCH

Summer grain

The past season was a good example of how erratic the rainfall in South Africa is. As a result of the excessive rain, crops could not be planted in the eastern production areas, and it was too dry in the western production area.

It is important for moisture to build up, to be conserved and to be effectively utilised. This may promote the stability of summer grain production.

The incidence of ear rot, caused particularly by *Diplodia* spp., spread to the western maize production areas during the past season, and a high percentage of maize was again downgraded. The quality of the harvest was detrimentally affected and the tonnage was drastically reduced.

Grain sorghum remains an important crop in areas with heavier soils and in areas with low-potential soil.

Breeding

During the past few seasons a gradual change has taken place in the local breeding programme. Private industry concentrates on the development of breeding lines and hybrids and the Departmental programme is aimed at the development of improved breeding populations by making use of appropriate selection procedures. A further approach is one where the whole plant is examined in a selection programme and where yield is the most important objective.

Two yellow and two white populations representing the various available heterotic groups were taken as the basic material. From this three white populations have already emerged, with increased tolerance to virus stripe disease. They have already been made available to private industry.

Cultivar adaptation

Yield and other data from maize and grain sorghum trials continue to make an important contribution in that it is possible to make a distinction between cultivars that have been adjusted to different yield potential conditions. Information on cultivar differences in respect of yield stability, which is very important particularly in making a choice of cultivar, are also obtained from these trials.

Moisture utilisation

The erratic quantity and distribution of rainfall in the Republic emphasises the importance of research into the effective utilisation of moisture. In studies

with maize in the North-Western Free State it was found that fertiliser placing has a definite influence on root development, and this in turn influences the utilisation of moisture from the deeper soil layers.

At four weeks after planting it was found that where fertilisers were placed at a depth of 500 to 600 mm in the soil, significantly more roots grew in that area than in normal band placing where fertiliser is scattered over a broad area. The differences in root development became smaller later in the season.

The rapid root development early in the season resulted in adequate moisture being available for the crop to develop to its full potential, especially where moisture collects in the deeper soil layers.

Planting date

Planting date trials over a period of 10 years have shown that the grain yield of maize in the Eastern Cape Sourveld (Dohne) is relatively constant with planting dates between August and November. Climate differences imply that farmers should rather plant a portion of the land each month to spread the risk. Silage yield follows the same pattern, except that August plantings yield less. The green maize yield shows a peak with October plantings.

In the Eastern Cape coastal area (Bathurst) grain yield is gradually declining from approximately 6 t/ha with July plantings to practically no yield with February plantings. Green maize yield follows the same pattern. Silage yield fares the best with planting dates between October and November.

Plant pathology

Ear rot - Surveys of fungi on maize that has been downgraded as a result of ear rot, shows that *Fusarium* spp. make up a greater percentage of the isolates in the western production areas, while *Diplodia maydis* makes up the greater percentage in the eastern production areas.

Studies of the survival and inoculant production of ear rot fungi are currently receiving the highest priority. It has been shown that stubble placement is the most important contributing factor. Survival and inoculant production were highest in partially buried stubble, fair in stubble above the soil and lowest in stubble that was buried. The observations were correlated with stubble cultivation, mulch cultivation and ploughing cultivation, respectively.

Boil smut - Research has shown that the artificial inoculation techniques that have been used up to now for genotype resistance evaluation do not give reliable results. This is a result, *inter alia*, of the use of wetting agents which conceal inherent resistance characteristics. A technique has been developed in which these agents are not used and which is regarded as acceptable by the breeders. A

measuring method linked to the crop losses that are caused by boil smut has been developed.

Ergot - Ergot is a particular problem in grain sorghum with regard to seed production. Most lines are very susceptible to the disease, but two populations which result in segregation and resistant genotypes have been identified. A model to identify and predict ergot-favourable weather conditions has been developed.

Stem rot and root rot - Sorghum lines with resistance to stem rot and root rot were identified. Resistance to root rot is accompanied by lignin development in the exodermis and chemical inhibitors. *Fusarium* spp. make up the highest percentage of root isolates.

Entomology

In an investigation into the ecology of stalk borers in grain sorghum it was found that egg laying by the maize stalk borer *Busseola fusca* takes place at a later stage of plant development than in maize. The result implies that the time calculation for chemical control will be more critical in grain sorghum than in maize. It was found that the sorghum borer *Chilo partellus* becomes established to a large extent behind leaf sheaths and this detrimentally affects the efficiency of chemical control.

An investigation into the economic value of different spraying regimes against *Chilo partellus* in maize showed that a single application of an insecticide can succeed in eliminating the largest part of expected losses. It was more economic to postpone the treatment than to apply control measures at an early stage of infection.

The combating of *Busseola fusca* in maize was more economic when the time of application was based on the economic threshold value in an earlier or later stage of infection.

Nematology

Surveys in the grain sorghum producing areas have shown that *Pratylenchus zeae*, *P. penetrans* and *P. crenatus* were the predominant endoparasitic nematode species. *Scutellonema brachyurum*, *Paratrichodorus minor*, *Paratrophurus anomalus* and *Rotylenchus devonensis* were the dominant ectoparasitic species.

Nematode populations were monitored over three years in five maize lands and three grain sorghum lands, but the populations did not increase significantly probably as a result of drought.

Efforts to breed the endoparasitic nematode *Pratylenchus zeae* in large numbers on cut-off maize radicles in the laboratory were successful.

Trials in co-operation with an Israeli agricultural research organisation have shown that a nematicide as a seed treatment (furatiocarb) effectively controls plant parasitic nematodes in maize.

In some cases it appeared that the emergence of maize can be suppressed at certain high doses, but

the trials did not show that the agent has any effect on the growth and development of the plants.

Plant nutrition

A fertilisation trial on Avalon soil in the North-Eastern Free State over the past four seasons provided useful information and clear guide-lines were found for optimum N and P fertilisation levels, calculated at a yield target of four tons of grain per hectare. It is essential that the trials be continued in both the western and the eastern low risk areas of the maize growing region.

A good indication of an optimum nitrate:ammonium ratio under field conditions was obtained. In accordance with this it will be possible to control the nitrate:ammonium ratio in the soil with the use of nitrification inhibitors. Glasshouse trials have proved that it is possible to lower the level of N application by optimising the nitrate:ammonium ratio.

The time of N application plays a very important role in N reaction. On a heavy clay soil it was proved that the optimum time of application is eight weeks after planting. Further investigations are being carried out into the optimum time of application on soil with a lower clay percentage, optimum quantities which should be applied in late stages and the correct N carrier.

The study on the nitrogen available to the plant in the soil began with the determination of mineralisable nitrogen from different soils. The quantities of mineralised nitrogen were used to determine mathematically how much potentially mineralisable nitrogen can mineralise from the different soils.

Glasshouse trials were undertaken to determine the take-up of nitrogen available to plants from various soils, both cultivated and uncultivated, and at varying depths. Grass which grows in soils with a high clay content (more than 40% clay), takes up considerably more nitrogen than grass which grows in soils with less than 30% clay. Cultivation did not have an effect on the take-up of nitrogen by grass and nitrogen take-up from the lower depths decreased. Lime applications stimulated the nitrogen take-up of the grass.

Field trials were carried out to investigate the transfer of nitrogen and to monitor the nitrogen balance during a season in the soil. Sharp reductions in plant-available nitrogen are obtained during the same season within a soil profile.

Weed control

Research in the field of weed control is conducted at Potchefstroom and at Cedara. At Potchefstroom research concentrates on (a) establishing the competitive effects of weeds on maize and grain sorghum, (b) studying the ecology of weeds which occur in maize fields and (c) developing a biotest for identifying atrazine residues in soils. At Cedara research concentrates on weed control systems in

conservation tillage, the control of winter weeds and herbicide evaluation. These research actions have the ultimate aim of providing information for cost-effective weed control.

It has been established at Potchefstroom that weed species differ in their competitive ability towards maize. The most competitive weeds have been identified as Wandering Jew (*Commelina benghalensis*) and common cocklebur (*Xanthium strumarium*) and the common grasses such as African goose grass (*Eleusine indica*) and feather-top Chloris (*Chloris virgata*) are the least competitive on a per plant basis. However, grasses tend to occur in greater numbers per unit than the two most competitive weeds mentioned above, resulting in a narrowing of the absolute competition differential.

It has been established that weeds differ not only in their ability to extract moisture from the soil but also in the soil depths at which moisture is extracted. Grasses tend to extract moisture from shallow soil depths, whereas broad-leaf weeds extract it from greater depths. Seed rain studies have highlighted the seeding potential of weeds. For example, a single purslane (*Portulaca oleracea*) plant produced 2,5 million seeds in a growing season and the common thorn apple *Datura stramonium* produced 100 000 seeds per plant in the growing season.

Studies on the development of a biotest for the identification of atrazine residues in the soil indicate that follow-up crops differ in their tolerance to atrazine. The relative order of tolerance was groundnuts, cotton, soyabeans, sunflowers, wheat and oats. Cultivars of each of these crops also influenced their tolerance to atrazine. Chlorophyll fluorescence was successfully used to assay low concentrations of atrazine in soil using oats as the test plant. This method appears to be fast and reliable and can detect concentrations of 0,25 mg/kg atrazine and lower.

At Cedara the performance of grass herbicides is being monitored on four different reduced tillage systems (direct drill, chisel plough, chisel and disc, mouldboard plough and disc). In no-till situations research on the control of winter weeds has indicated that two of the cheapest treatments, viz 2,4-D followed by paraquat and 2,4-D followed by glyphosate, showed the greatest promise for effective winter weed control. Other treatments containing 2,4-D also showed good control.

Small grain

Breeding

The line T83/7 was released under the name Malopo for the dryland winter wheat regions. This cultivar will be very well suited to the industry and, together with Tugela and Molen, should make up an almost perfect package for wheat production in the Free State. The performance of this line in field trials places it in the same stability category, with a slight increase in production, as that of Betta, which has dominated wheat production particularly in the

Eastern Free State for several decades.

Spring wheat cultivars such as Palmiet, Gamtoos and Harts continue to be very popular. These wheat types, which resulted from the national breeding programme of the Small Grain Centre, represent the achievement of the original objectives set in the middle of the previous decade, namely broad adaptability together with excellent production potential.

The new releases attained yields of up to five tons per hectare under dryland conditions over a wide front, while older cultivars such as Scheepers could hardly produce two tons per hectare.

Cultivar adaptation

The proper adaptation of wheat cultivars in specific production areas remains a very high priority. If a producer makes the correct cultivar choice, up to 60% of his success is ensured. All the indications are that Scheepers 69 is losing its status in the Free State to other cultivars that perform better.

At present only 17 wheat cultivars are recommended under dryland conditions in the whole summer rainfall area, compared with eight cultivars under irrigation. In the winter rainfall area nine cultivars are recommended. These recommendations are made from 60 wheat varieties that are still cultivated.

In the Winter Rainfall Region, a low emergence percentage of the seed, i.e. as low as 50%, is experienced and this makes the correct planting density considerably more difficult to obtain. This matter will receive more attention.

Physiology

From the study of drought tolerance it appeared that SST25 was not easily affected by moisture stress, whereas SST107 showed the opposite reaction. All the wheat lines evaluated in the Free State under dryland conditions have a coleoptile length of over 60 mm, which is a requirement for good adaptation. The unfavourable characteristic manifested by Scheepers 69 of forming secondary roots near the soil surface is found less and less in the new breeding lines.

An evaluation of aluminium tolerance showed that the two new wheat releases, Gamtoos and Tugela, have a good tolerance, although local germ plasm generally lacks this characteristic.

On evaluating wheat cultivars at different day lengths, it was apparent that SST107 developed optimally at a day length of over 10 hours, whereas SST25, Molen and Tugela respond favourably even when subjected to the short day length.

In a glasshouse trial in the Winter Rainfall Region early sprayings of wheat with Chlormequat (CCC) gave better results than later sprayings. Shorter but broader flagleaves and shortened culms were obtained in this way. In a field trial CCC considerably reduced the culm length, reduced lodging percentages and resulted in an average yield increase of 13,9%.

Soil cultivation with wheat

The results of a soil cultivation trial on an Avalon soil at Bethlehem indicate that evaporation of ground water and water drainage were considerably less in a no-till situation than on mulched plots or plots cultivated with a mouldboard plough.

The trends which became apparent from the evaporation and water drainage data can possibly be explained on the basis of the gross density of the 0 - 300 mm soil layer.

Wild oats control in corn

Wild oats are at present the most common weed affecting wheat. Chemical control can at present be successfully applied only in the winter rainfall and irrigation areas. However, in the dryland summer rainfall areas the weed cannot be successfully controlled chemically. Trials have been undertaken to determine reasons why chemical control is unsuccessful.

It has been determined that various biotypes, which differ from each other both morphologically and in respect of tolerance to wild oats agents, are found in *Avena fatua*, *A. ludoviciana*, *A. sterilis* and *A. byzantina* which appeared throughout the whole country. The tolerance of biotypes varies for various active ingredients of wild oats agents and only some biotypes are better controlled with increased doses. At present the alternative use of more than one active ingredient seems to be the only way to prevent the build-up of tolerant populations.

Plant nutrition and moisture

From results obtained with wheat under irrigation it is clear that the entire amount of nitrogen fertiliser should be administered before growth stage 10 if it is to have any effect on the grain yield. Nitrogen applications at a later stage do have a positive effect on the protein content of the seed, but the premium currently paid for wheat grain with a higher protein content is such that one can no longer consider adapting fertilisation practices for this reason.

Under dryland conditions it is clear that a yield response can indeed be obtained in the eastern areas, but that one should be conservative about nitrogen fertilisation in the central and western wheat-producing regions of the summer rainfall areas. Even in the almost ideal conditions in the Eastern Free State, the yield response obtained with phosphorus fertilisation is limited to approximately 10 to 12 kg of P per ha. At these fertilisation levels the soil phosphorus status is not detrimentally affected.

On the Springbok Flats it would seem that little response is obtained with nitrogen, phosphorus and potassium fertilisation and, as in the Western Free State, one should fertilise conservatively.

As a result of poor climatic conditions, trial

results in the Eastern Cape coastal regions were collected from one locality only. These results show that no yield reaction is obtained with high nitrogen or phosphorus fertilisation levels. This confirms the guide-lines that are currently being used in this area.

The influence of different levels of phosphorus on the water consumption of dryland wheat is being investigated in the Free State region. During the vegetative growth phase of wheat, treatment in respect of the higher phosphorus levels showed a better growth, but during the reproductive growth phase it became clear that the rank wheat suffers more from soil water stress than the wheat which received smaller phosphorus applications. This was also reflected in the grain yield.

In the Winter Rainfall Region high nitrogen fertilisation in malting barley did not increase the yield, but resulted in undesirably high nitrogen levels in the grain.

Espacement

In a row espacement trial in the Winter Rainfall Region 17,5 cm rows yielded more ears per square metre than 35 cm rows and yields were therefore considerably greater. In a forage grain trial triticale fared better than barley.

Plant pathology

The influence of climate on the incidence and intensity of soil-borne diseases was again clear during the past season. Where the Swartland, for example, used to be plagued mainly by crown rot (*Fusarium*), the high rainfall caused foot rot (*Gaeumannomyces*) and eye spot (*Pseudocercospora*) to occur widely in this area. These diseases were to a large extent assisted by the annual successive cultivation of wheat on stubble lands. Research results show that it is possible to control a problem disease such as foot rot in a practical way by means of nitrogen fertilisation, soil cultivation and other management practices. In country-wide investigation into the incidence of leaf diseases in wheat and related small grains the following was found:

Climatic conditions in the Eastern, Southern and Western Cape are very suitable for epidemic outbreaks of leaf diseases in small grains.

Bacterial scorching diseases were in the past incorrectly identified as leaf spot diseases caused by fungi.

The unsuccessful utilisation of fungicides on wheat and barley can in many cases be attributed to the incidence of bacterial diseases which are confused with fungal diseases.

For the coming season extended trials in the Winter Rainfall Region are planned in order to determine the effect of various leaf diseases separately and jointly on grain yields.

Research on rust diseases is being focused on wheat stem rust (*Puccinia graminis*) and white leaf rust (*Puccinia recondita*). Only cultivars with

adequate resistance to stem rust are recommended in areas where this disease may be a problem. New rust races which affect cultivars that were formerly resistant are, however, still being discovered. Research indicates that the increase of such races depends largely on the popularity of a cultivar.

A spring cultivar with full resistance to leaf rust has been released recently. A single gene LR26 is responsible for the resistance of this cultivar. A disturbing finding, however, is that a rust race that is virulent on LR26 has been found in the past year on Zambian and Zimbabwean wheat.

Entomology

Wheat lines with resistance to the Russian wheat aphid have been identified in material from Russia and adjoining countries where wheat has been exposed to the aphid for many years. Success was achieved after the development of a suitable method of evaluation for resistance. It was established that the resistance is dominant and that it is produced by a single gene. The breeding of genes that produce resistance to existing adapted winter and spring cultivars is proceeding favourably.

The grain aphid complex is the largest single entomological problem in small grain production in the Winter Rainfall Region. Crop potential losses of 36% (wheat) and 46% (barley) were measured at Tygerhoek.

Although adequate and effective chemical control agents are available, control is complicated by the fact that five different grain aphid species can be involved which can colonise the grain plant at various times during the growth season. It was determined that planting times play a role in the incidence of the various aphids and that the aphids are found in greater numbers where grain leaf diseases are chemically controlled.

Oilseeds and protein seeds

Groundnuts

Two new groundnut cultivars, Harts and Norden, were released last year. Harts is a type with a short growth season and Norden is a runner type with a long growth season. Both have good resistance to black pod rot (*Chalara elegans*). With the renewal of breeders' seed of selection 5 and Natal Common, five groundnut cultivars are now available. This means that the groundnut farmer now has a wide selection for both dryland production and production under irrigation.

In the Schweizer-Reneke area it was found that lesions on seed and pods can be attributed to nematode infestation. The organism which causes this is the potato rot nematode *Ditylenchus destructor*. A survey shows that this nematode is widely distributed in the Republic of South Africa and that the infestation level varies in various areas from very low to alarmingly high.

A task group was immediately formed to

research all aspects of the pest.

A survey on groundnut lands in the Highveld Region showed the presence of a variety of soil insects. It was also clear that the insects cause considerable damage to pods and kernels, and they are also largely responsible for the downgrading of the crop.

Sunflowers

Studies on nematode infection in sunflowers have shown that, particularly in the Western Transvaal, the root knot nematode *Meloidogyne javanica* can contribute to considerable crop losses if sunflowers are grown season after season on infected soil. Apical chlorosis made its appearance on sunflowers during the year. The disease is identified by a yellowing of half of a sunflower field which, depending on the prevalence of the disease, can result in crop losses. The disease is caused by bacteria which belong to the *Pseudomonas* group. Invasion by the bacteria takes place after mechanical damage, for example by hail.

Soya beans

Soya bean production in the Republic of South Africa during the past year exceeded the 50 000 ton level for the first time. The research programme of the Oilseed and Protein Seed Centre is aimed mainly at breeding and cultivar evaluation.

As a result of the high input costs with soya beans it is essential that all factors involved in achieving optimum yield be identified. The development and refinement of a growth simulation model for soya beans which is suitable for South African conditions is a high priority. Further refinement will be facilitated in the future by the use of new phytotron facilities that are currently being erected at the Grain Crops Research Institute.

As a result of the serious protein shortage for stock forage in the Republic of South Africa future research into this crop will be aimed increasingly at optimum production under dryland conditions.

Dry beans

Unacceptable canning quality and susceptibility to rust means that the small white canning bean Kamberg must be replaced as soon as possible. It is a great pity that this cultivar has to be removed from the industry, since it gives a yield that would be difficult to improve on. Since the traditional types of bean that are produced in South Africa are not sought on the overseas markets and since there is also a shortage of larger types of packing beans, the Oilseed and Protein Seed Centre has initiated a new breeding programme in which these types will receive greater attention in the future.

The negotiations in respect of the transmission of the disease free seed scheme for dry beans to the Dry Bean Board has already reached an advanced stage and it is hoped that they will be completed in the coming year.

Owing to the acquisition of additional sources of resistance and the availability of a full-time plant pathologist for dry beans more attention will in the future be given to the identification of bean rust races and the building-in of specific resistance genes for South African needs.

Lupins

In wild Portuguese populations and other overseas introductions - both wild lines and sweet cultivars - the chilling requirement was determined and the effect of vernalisation was quantified. On the basis of these results material was selected which can be used in a winter and a summer crop cultivation system and in breeding programmes. Cultivars are already being tested in winter plantings (June - August).

The alkaloid content of all sweet cultivars and advanced selections were also quantitatively determined. All advanced selections and most of the cultivars had an alkaloid content of 0,02% or even lower and it should therefore be possible to incorporate them successfully in forage.

In the breeding programme 37 lines were selected which in two Highveld localities surpassed both the standard in yield and the stand at harvesting. Resistance to soil fungi (*Fusarium*) and high temperatures are probably involved. These lines are currently included in a variety trial. Furthermore, lines with a shorter growth season are also being developed.

In the past season seven cultivars were evaluated in 12 areas and six localities. Average trial yields ranged from 4,7 t/ha at Wildebeesfontein (Hendrina) with a planting time at the beginning of September to 1,5 t/ha at Ermelo with a planting time in mid-November. In general higher yields are obtained with early planting times. The cultivar Hamburg, in particular, gave very high yields with the early planting times - up to 6 t/ha.

In plant population trials it was again found that high yields in both a low planting density in wide rows and a high planting density in narrow rows are possible. At this stage it would appear that the last combination may be more beneficial with late plantings.

Results of the cultivar trials in the Winter Rainfall Region indicate that *Lupinus albus* is well suited to the heavier soils of this region and that the seed yield potential is considerably better than that of *Lupinus angustifolius*. It further appears that *Lupinus albus* prefers a narrow row spacing, as for wheat, and gives the best seed yields at a density of 45 plants/m². The application of a seaweed growth regulator could not bring about a significant improvement in seed yield.

Broad beans

Broad beans (*Vicia faba*) are well adapted in the largest part of the *Winter Rainfall Region* and as a rotation crop should be a very good alternative legume for lupins. On the heavier soils the seed yield of broad beans was much higher than that of

Lupinus angustifolius and *L. albus*. In addition, very good results were obtained with the post-harvest utilisation of the crop residues and seed by sheep. Broad beans also seem to be suitable for inclusion in pig and poultry growth diets.

Cow peas

Additional germ plasm was obtained and together with the existing collection was planted for seed propagation and the description of 29 plant characteristics on the basis of an internationally recognised key. Seed from the first 136 entries already mentioned have a high protein content of 24,5% to 32,8%. These lines were planted at Potchefstroom, Schweizer-Reneke, Vaalharts and Warmbaths for evaluation of yield potential (seed and dry material) and representatives of the growth forms were planted at Potchefstroom for their planting date reaction. Promising germ plasm was planted for purification in respect of uniformity and seed-borne viruses at Vaalharts. Single plant selections from the previous year were evaluated in a late planting at Potchefstroom for virus resistance or tolerance.

Other crops

Tobacco

Breeding

The breeding line OD86 was evaluated for a second season in Phase 2 flue-cured plantings. If it is found to be acceptable in smoking trials, the breeding line will be released for commercial planting. The breeding line OD212 was recommended for Phase 2 trials.

In the air-cured programme the combination CDL28 x WPRS is now in Phase F4 and is showing a high degree of resistance to black shank; after a further generation in the greenhouse this selection will be moved up to Phase 1 next season.

The imported line TN86 has proved to be an important addition to the Burley breeding programme from the point of view of both quality and disease resistance.

In the Winter Rainfall Region three imported oriental breeding lines are being evaluated in Phase 2.

Diseases and pests

Black shank - Residues of the new experimental preparation in tobacco leaves compare well with those of metalaxyl. Cigarettes are made from impregnated tobacco for use in smoking trials.

Bacterial wilt - The South African line of this pathogen has been found to show little similarity to lines from Zimbabwe, Colombia or Florida. The South African lines, all of which fall into the biovar 3 group, show the greatest similarity to a biovar 4 line from Australia.

Unless other lines exist in Zimbabwe that were not included in this research programme, it may be assumed that the disease did not spread to South Africa but broke out independently here.

Chemical control with a chloropicrin and EDB mixture may be effective, depending on the population of bacteria in the soil and on how efficiently the preparation is administered. The chief difficulty, however, is to determine the status of the bacteria in the soil accurately so that the desirability and success of treatment can be gauged, within limits.

Viral diseases - Surveys of viral diseases were carried out in the Lowveld, Groblersdal and Potgietersrus tobacco areas. Tobacco mosaic virus (TMV) was not found anywhere. Cucumber mosaic virus (CMV) was found in only 5% of cases in the Lowveld, but 80% of the samples from Groblersdal and the Springbok Flats were infected with CMV. On the other hand 70% of the samples from the Lowveld were infected with potato virus Y (PVY) as against only 15% of the samples from Groblersdal and the Springbok Flats.

The ELISA technique is the most suitable for this investigation. Most tobacco viruses are carried by plants growing in tobacco fields or in the immediate vicinity of fields, chiefly plants belonging to the families Solanaceae, Cucurbitaceae, Cruciferae, Leguminosae and Gramineae. Weeds such as thorn apple, common purslane, wild gooseberry, wandering jew and starwort, which are frequently found in tobacco fields, are also susceptible to tobacco viruses.

Two *Nicotiana* species, namely *N. alata* and *N. sanderae*, showed a hypersensitive reaction to an isolate of the tomato spotted wilt virus (TSWV), whereas *N. forgetiana* showed resistance. Of the breeding lines tested, only GAT 4 showed resistance to all the available tomato spotted wilt isolates.

Nematodes - The susceptibility of most rotational crops and weeds that are associated in some way with tobacco to species and races of *Meloidogyne* is now known. Wheat cultivars recommended for cultivation in the summer rainfall areas, such as SST44 and Zaragoza, are very susceptible, particularly to race 4 of *M. incognita*, which is very generally found. Maize, oats and barley cultivars are less susceptible. Some weeds are also very susceptible and populations can build up to a harmful level. In chemical control trials EDB and aldicarb provided the best control of various nematode species.

Tobacco spider mite - The tobacco spider mite is showing resistance to certain organophosphates. Monocrotophos at twice the registered dose provided some degree of control.

Aphids - A positive correlation was found between the incidence of PVY in tobacco and aphid catches.

Plant nutrition

The movement of N in the soil and its influence on tobacco quality was investigated. It was found that

after six weeks excessive leaching rain as a result of leaf cover had a minimal influence on the N nutrition of tobacco.

Attention was also given to the cation nutrition of tobacco, particularly the interrelationship of cations that affects potassium uptake, where the trace element status of the tobacco plant is very important in determining the quality of the end product. A survey was begun with the object of determining the trace element status of tobacco in the tobacco-producing areas as associated with soil type.

Cotton

Crop cultivation

Control of vegetative growth - Results obtained with the growth inhibitor mepiquat showed that a programme of spraying with low concentrations administered repeatedly is safe for use on cotton and is capable of controlling excessive growth. The correct interpretation of growing conditions remains an important function of the farmer if he is to be successful.

Drip irrigation - It emerged clearly that very high yields can be obtained with drip irrigation. Yields of six tons/ha or more are possible but require outstanding management of the system.

Moisture stress - The determination of a moisture stress index was a notable research achievement. The index is especially useful in irrigation scheduling. Moisture stress trials showed that there are major differences between cultivars with regard to recuperative powers and drought tolerance.

Breeding

Advanced and recently developed elite cotton lines are being evaluated in all four breeding programmes. Four breeding lines from the Upington breeding programme were found suitable for further evaluation in the National Cultivar Trial. Two breeding lines from the Vaalharts breeding programme were included in the National Cultivar Trial.

Diseases and pests

Seedling diseases - The chief cause of seedling diseases in both dryland and irrigated cotton was *Rhizoctonia solani*. *Fusarium* spp. and *Macrophomina phaseolina* play a contributory part. Seed treatments with carboxin/thiram, iprodione, pencycuron, tolclorophos methyl and triadimenol as well as in-row applications of quintozene and quintozene/ethridiazole in granular form significantly reduced seedling disease caused by *R. solani*.

Bacterial diseases - In the course of the season samples of infected plant material were collected from Kroondal, Koedoeskop, Nondweni, Mara,

Letsitele, Delareyville, Weipie, Komatipoort, Hectorspruit, Pongola, Loskop, Settlers, Brits, Makatini, Mkuze, Naboomspruit and Ohrigstad. About 300 isolates of *Xanthomonas malvacearum* were obtained and the distribution of the various races of the disease is being determined.

Cotton weevil (*Apion soleatum*) - The distribution area of this insect has increased. In view of this the legislation that restricts the cultivation of ratoon cotton was amended to include the new distribution areas.

Resistance to bollworm - Cotton lines with different morphological characteristics were evaluated for resistance to the bollworm complex and flea beetles. Gossypol-free cotton proved very susceptible to the flea beetle *Nisotra weisei*.

Spider mite - Results obtained from work on spider mites indicated that the cultivars/breeding lines Tetra, OBS 83/259 and OBS 83/31 are less susceptible to spider mite infestations.

Chemical analysis was carried out in respect of the nitrogen, phosphorus and sugar contents of the various cultivars and it appeared that cotton with a higher percentage sugar content was more susceptible to spider mite infestation.

Peppermint

The influence of harvesting stage on the yield and quality of peppermint oil was investigated at Elsenburg, Oudtshoorn and Villiersdorp. Optimum yield and quality were obtained in flowering stages five to nine. In these growth stages the ratio of menthol to menthone in the oil was also very favourable, i.e. 40% menthol and 10% menthone.

HORTICULTURAL RESEARCH

Pomes, drupes and other fruits

Apples

Breeding - Of the 48 388 seedlings originating from the local breeding programme and currently established in orchards, 26 promising selections were promoted to Phase 2 for further evaluation. This seedling population comes from crosses with Cox's Orange Pippin, Golden Delicious and existing commercial cultivars. Cox's Orange Pippin types are still in great demand in the United Kingdom and better types that are suited to South African conditions are essential. The breeding programme is aimed at meeting the need for late red cultivars and Golden Delicious types that are not subject to russetting. Promising compact Granny Smith types have been bred with mutation breeding and these selections are currently being evaluated further for fruit characteristics and production capacity.

Approximately 184 new cultivars, selections and clones are currently being evaluated in plots in the most important apple production areas for fruit

characteristics and production capacity. A further 65 cultivars were imported. Six cultivars with a low chilling requirement were further identified for planting in the northern areas and are being evaluated there at present.

Horticulture - The fruit size prediction model which has been successfully used since 1984 in experimental orchards to predict fruit size at the harvest date at an early stage and to adjust the crop so as to ensure maximum income is currently being investigated in commercial orchards. Results collected during the previous season indicate that the model can be used just as successfully in commercial orchards, provided that adequate data are collected.

Investigations into the use of cyanamide as a dormancy-breaking preparation in apples have shown that the preparation can be used with great success, particularly in the case of young trees, and has better results than the existing preparation, DNOC winter oil. However, the application on full-bearing trees did not increase production to an extent which justified the higher costs.

Physiology - Owing to consumer preference for smooth apples rejections for exports as a result of stem end russetting again amounted to several million rands this year. Large differences in respect of this abnormality are found between lateral and terminal fruits from the same bunch. If only the lateral flowers or fruit can be successfully removed during thinning, the percentage of exportable apples can be considerably increased. There were also indications that certain breaking and thinning agents can reduce stem end russetting.

Various treatments for chemical thinning in apples were evaluated over a period of three years. Initial results showed that scorching agents were not suitable since they caused an unacceptable increase in russetting in both Golden Delicious and Granny Smith cultivars.

Control of superficial scald of apples is costly and diphenylamine (DPA) residues on fruit are undesirable. Research done in the past season confirmed that the concentration of the DPA used can be decreased by about 50% without losing efficiency. When this is implemented by the apple industry it will bring about substantial savings.

DPA wettable powder was always used to control superficial scald on Starking and other red apple cultivars because the use of DPA emulsifiable concentrate (DPA ec) aggravated the incidence of wet core rot. However, when water used for hydro-dumping is chlorinated and a suitable registered fungicide is added to the DPA ec, it can be used without risk.

Nutrition - Fertilisation recommendations for deciduous fruits are based on the saturation of the exchange complex and consequently the determination of the cation exchange capacity of orchard soils is extremely important. The best estimate of cation exchange capacity was obtained with unbuffered solutions with a low ionic strength. Consequently the silver thio-urea method is recommended for routine use.

Pests - The deciduous fruit industry is to a

great extent dependent on exports to overseas countries. Such fruit has to comply with international phytosanitary quarantine requirements of importing countries regarding insect infestation.

Apples and other deciduous fruit are subject to infestation by fruit flies. The use of gamma radiation was investigated as a possible quarantine treatment for packed export apples as an alternative to cold-disinfestation.

Radiation doses have been determined which will prevent the adult emergence of fruit flies from pupae. It is therefore technically possible to disinfest export fruit by radiation, should such post-harvest phytosanitary treatment ever become necessary.

Pears

Physiology - In a significant number of cases of pear plantings in orchards where pears were previously grown, trees grow poorly as a result of specific re-establishment disease. In order to eliminate unnecessary methyl bromide fumigation, a start was made this year on a biotest, similar to that for specific re-establishment disease in apples, to try to predict the incidence of the disease. Initial results indicate that such a biotest for the prediction of re-establishment disease in pears is in fact possible.

Technology - Controlled atmosphere storage of pears is being investigated together with that of apples. Pears are stored annually on a larger scale. Not all cultivars react the same way to CA storage and it is necessary to investigate the behaviour of each cultivar during CA storage. It appears that ripeness and area differences determine the storage life of pears. The storage life of Forelle, Doyenne du Comice and Winter Nelis can be extended by two months or more, but Beurre Bosc develops internal decay and rotting during CA storage.

Peaches

Breeding - A further 6 470 seedlings were established during the previous year in evaluation plots. Selection yielded 11 promising yellow-flesh dessert peaches, six yellow-flesh nectarines and one white-flesh dessert peach. One canning selection and three dessert peaches are currently being considered for release in the Western Cape and the Transvaal and two cultivars were also identified for release to Natal producers. The release in 1987 of the new dessert peaches Desert Pearl and Don Elite and the nectarine cultivar Donnarine from the local breeding programme has already made a significant contribution to the improvement of existing cultivars.

Physiology - Pitbrand is a physiological disease in yellow cling peaches which is found sporadically and causes serious losses for canners as a result of browning in the stone hollow. Observations in previous seasons have indicated that this problem is probably linked to high temperatures during or shortly before the harvesting of Kakamas peaches, in particular. These climatic conditions are experienced

practically every year to a greater or lesser extent in the Western Cape. Results obtained in the previous season indicate that the prevalence of pitbrand under such climatic conditions can be largely eliminated by picking and immediately processing fruits at the optimum ripeness. Overripe fruits and cold storage largely increased the prevalence of the problem.

Sponginess is the most significant limiting factor in the export of peaches and nectarines. It has been determined that sponginess is a natural stage in the ripening process of the fruit and that long cold storage periods only make the problem worse. The spongy stage can be curtailed and speeded up by ripening the reducing nectarine at a high temperature. Alternative methods of reducing or avoiding sponginess have already been passed on to the industry.

The pollen of 42 peaches and nectarine cultivars was investigated during the past season and a few striking characteristics of the pollen surface patterns were noted. There are positive indications that the cultivars will eventually be able to be differentiated from one another on the basis of pollen patterns.

Pathology - Wound pathogens, such as *Mucor piriformis* and *Penicillium* spp. caused most post-harvest decay in peaches and nectarines, but *Botrytis cinerea* and *Monilinia laxa* were also important post-harvest pathogens. The high incidence of wound pathogens is due to injuries on fruit surfaces.

Technology - The quality of peaches preserved in aluminium laminated plastic bags compared favourably with those of peaches in standard cans. The processing temperature is lower when plastic bags are used instead of cans and for this reason the texture of fruit in plastic bags was better than that of fruit in cans.

During the past year there has been an increasing demand for canned peaches on the fresh market and this made a re-evaluation of ripeness standards necessary. Fruit colour was the only reliable way to measure ripeness. Fruits that were more yellow than green at harvest stored well. Mass loss during storage is approximately 5%. Storage conditions must be carefully controlled to limit mass loss as a result of low humidity.

Plums

Breeding - More than 3 600 seedlings from the local breeding programme were established in evaluation plots during 1987. Two promising black plum selections were identified for release. These selections will make a significant contribution towards meeting the greater demand for black plums and may also lengthen the harvesting season by approximately two weeks.

Horticulture - Applications of palcobutrazol on Songold plums during the post-harvest period significantly reduced length growth of one-year shoots and promoted the development of seedheads. It also shortened the flowering period. The problem with weak set as it appears in this cultivar might

possibly be reduced by the control of excessive growth and further investigations have been started.

Physiology - Internal decay is a physiological disease in plums which since the start of the 1980s has caused serious problems on overseas markets and consequent economic losses for producers. It is most frequently fruits of the Songold cultivar and, to a lesser degree, Santa Rosa that are subject to internal decay. It has been found that rank growth aggravates the problem severely, particularly if it is accompanied by poor fruit set, a problem often found in Songold. Furthermore, the prevalence of the disease is reduced by high Ca levels and high Ca/K and Ca/Mg ratios in the leaves and fruits. Norms for leaf and fruit composition of plums have been established to limit the occurrence of internal decay.

Over the past three years efforts have been made to manipulate the fruit set and fruit size of plums with the aid of various scorching agents. Results indicate that the preparations resulted in over-thinning. The thinning of plums is, therefore, not economically justified at this stage.

Pathology - Blossom blast/brown rot is one of the three most important diseases of plums and other drupes. This disease can be the cause of up to 80% of the losses of blossoms. Losses as a result of brown rot in fruit on arrival at overseas markets are just as serious.

It has now been found without doubt that long-term dormant infections do not play a role in fruit losses as a result of brown rot. The disease does have a deleterious effect on blossoms and fruit ripe for picking. It can be limited only by the wise and careful application and operation of existing chemical control before and during flowering and before harvesting in ripening fruits.

Botrytis cinerea caused the most post-harvest decay in plums and *Monilinia laxa* the second most. More rhizopus decay was found than in the past.

Apricots

Breeding - A further 5 400 seedlings from the local breeding programme were established in evaluation plots. At present 67 promising selections have been identified and these are being evaluated further. Since 1974, 258 promising selections have been evaluated further and of these the Palsteyn, Super Gold and Soldonné cultivars have been released.

Technology - The fumigation of apricots with sulphur dioxide prevents quality losses in dry apricots. Careful control of the sulphur dioxide concentration is important to ensure that residues on the fruit remain within limits. When the Peekapara apricots are treated with sulphur oxide under controlled conditions, most of the sulphur dioxide is taken up during the first four hours. The practical implication of this is that the fumigation time can be shortened if the conditions under which the fumigation is being carried out are strictly controlled.

The degree of ripeness at which apricots are

harvested and the post-harvest handling determines the quality of the apricots after storage. The optimum degree of ripeness is a fruit firmness of 5,5 to 7 kg. This firmness should, however, be linked with a standard which can be easily interpreted by pickers. It was found that a green-yellow to full yellow fruit colour corresponds well with the optimum ripeness stage.

Nutrition - Application of a low-grade compost during soil preparation on a sandy soil at the Citrusdal Experimental Farm led to a 70% improvement in the yield of apricot trees in the fourth year after planting. Compost increased the cation exchange capacity of the soil and consequently led to a decrease in leaching losses. Furthermore, the water holding capacity of the soil improved considerably. These are the first positive results obtained with compost in the Western Cape that can be traced back to an improvement in the soil characteristics. The application of compost for this purpose can therefore only be recommended on very sandy soils.

Kiwi fruit

Horticulture - Investigations into the use of cyanamide as a dormancy-breaking agent in cultivars of kiwi fruit with a high chilling requirement, blackberries and blueberries were very successful. There was a significant increase in the production of these fruits and further investigations into optimum concentrations and times are continuing. In the absence of adequate cultivars with a low chilling requirement, the use of this agent can make an important contribution to the expansion of these industries. However, the evaluation of imported cultivars and local selections from the breeding programme continues and a promising kiwi fruit cultivar with a low chilling requirement has already been identified.

Strawberries

Technology - A limited quantity of strawberries are exported annually by air. The costs are high and interest has been expressed in techniques to export strawberries by ship. During controlled atmosphere storage in an atmosphere which contains 4% oxygen and 10% carbonic acid gas and a temperature of -0,5°C, strawberries retain their quality for three weeks, with a shelf life of two days. Export by ship is therefore possible. However, at present there are no facilities to create CA conditions on board ship.

The retention of quality during export by air is also important. Short exposures (one day) to high carbonic acid concentrations and irradiation, and irradiation combined with CA storage, limited quality losses, but not to the same extent as quick cooling to 5°C. Quick cooling and maintaining a low temperature is therefore at present the most effective way to limit quality losses in strawberries.

Rooibos tea

The early die-off disease in rooibos tea is a serious impediment to the continued existence of the industry and its growers.

A total of five types of fungus have been identified as causes of the disease, three of which constitute the main cause. It was found that they are seed-borne and survive on dead rooibos tea tissue above and below the ground.'

The result of the research is a breakthrough and makes a very important contribution to the survival of rooibos tea cultivation. A number of practices have been identified, worked out and defined for application by growers to eliminate losses due to early die-off.

Viticulture

Nurseries

Various techniques for the cultivation of grafted vine-cuttings in nurseries were investigated. The use of black plastic ground cover in ridged banks in nurseries significantly increased the percentage class 1-vines. This can be attributed to a more favourable soil temperature in the root zone, with the result that there is better root development than when no plastic is used on ridged banks.

Rootstocks

During the past five years 241 graft combinations of 18 scion cultivars and clones and 14 rootstock cultivars and clones were evaluated for compatibility on a continuous basis. Five vines of each graft combination tested in the nursery were established for long-term observations for affinity.

The rootstock 104 Paulsen does not grow very well in an Oakleaf/Westleigh soil type, while Ramsey, Constantia Metallica and US 24-41 have very poor affinity with Muscat d'Alexandrie.

In respect of crop the rootstocks Berlandieri 13/5, 775 Paulsen and 101-14 Mgt (>50 ton/ha) are faring much better than the US crosses, e.g. 12-6-8; US 16-13-26 (>20 ton/ha). A root study has shown that there is a direct connection between growth above and beneath the soil. It was found that the first-mentioned cultivars utilise the available soil volume better, which explains the increased yield in these cases. Under the experimental conditions it was found that rootstocks which induced a higher yield also produced wines of a higher quality.

Trellising systems

Crop yield differences that are found when different vine trellising systems are used are clearly a function of budding percentage and eye fertility. Different trellising systems have different effects on foliage density and this results in differences in the light intensity within the canopy. This situation can have

a negative or positive effect on the budding percentage and eye fertility, depending on the degree of density of the canopy. It was also found that vertical trellising systems are often too small to accommodate the excess vegetative growth in most of the summer rainfall areas.

Physiology

The photosynthetic activity of vine leaves decreases progressively with time. Photosynthetic products are mainly retained in the leaves up to the berry set stage, after which they are increasingly translocated to the clusters. The apical leaves showed the highest photosynthetic activity compared with the leaves opposite and beneath the clusters.

When 33% and 66% of the leaves on a vine are evenly removed, the remaining leaves of these vines develop a higher photosynthetic activity than those of the untreated vines. However, the distribution pattern of photosynthetic products of treated and untreated vines did not differ. It was found that in the case of the untreated vines too many leaves were being carried, with the result that the optimum photosynthetic activity of all the leaves on the vine could not be attained.

Harvesting stage of table grapes

The size and colour of table grape berries are often used to determine the correct harvesting time. However, these criteria can be misleading because they are largely dependent on climatic conditions and viticultural practices.

In an effort to determine the optimum harvesting stages of table grapes, the maturation and eating quality of two newly released cultivars, viz. Bellevue and Dauphine, were studied in comparison with those of the well-known cultivar Waltham Cross. As a result of an increased demand for seedless grapes, Sultanina was also included.

All cultivars showed a normal steady increase in sugar concentration that levelled off at various stages, depending on the cultivar. As judged by consumer preferences, it was concluded that both Waltham Cross and Bellevue should be harvested at or above a sugar concentration of 15 °B. This minimum value was found to be slightly higher for Dauphine, viz. 15-16 °B, and considerably higher, at 17-18 °B, for Sultanina.

Although the sugar:acid ratio of berries is also used in practice to indicate maturity, this study showed that the sugar concentration alone can serve as an index of acceptable eating quality in the case of Waltham Cross, Bellevue and Dauphine. However, in the case of Sultanina, the acid content as such should also be taken into account. For all four cultivars studied, the sugar:acid ratio was found to be very variable and generally unsatisfactory as a maturity index.

Vineyard pests

Margarodes are subterranean insect pests which are being found more frequently in South African vineyards and cause serious damage. Since no control measures against this pest are known, field trials were carried out over a period of four years in the Orange River Irrigation Area to control the pest chemically. Excellent control has been obtained with hexachlorobutadine. Applications on a commercial scale have also been successfully tested and the best time of application has been determined.

Arrangements are currently being made to import hexachlorobutadine into South Africa and to register it for local use. The findings are also important for other countries, especially in South America, where the pest causes economic damage and where no control measures are known either. Over the past few years nematodes have seemed to become increasingly important in the vineyard from an economic point of view. Surveys have shown that parasitic types are found in practically all vineyards. Research has further shown that the four general species of the economically most important group, i.e. root-knot nematodes (*Meloidogyne* spp.), all attack vineyards. It was further determined that temperature does not only influence the reproduction rate of these nematodes, but also increases the vineyard's susceptibility.

A total of 53 rootstock cultivars were evaluated for resistance to root-knot nematode. 10 resistant cultivars were identified and 20 fairly resistant, 14 fairly susceptible and nine susceptible cultivars.

The chemical control of nematodes in vineyards was investigated further. After various agents were evaluated over a number of years in field trials, two were registered for application in established vineyards. The positive reaction resulting from treatments with these agents on vines which are resistant to root-knot nematodes, indicate that other parasitic nematodes might be of greater economic importance than is generally thought. Pot trials with these agents showed that treatments are less effective after infection has already taken place. Although the agents have a systemic effect, early applications, before the start of root growth in the spring, are therefore important.

Vine diseases

Acid rot causes great losses in wine and table grapes every year. Field trials have indicated that the disease is caused by various fungi, but that the fungi can only enter the berry if the skin is damaged. Wounds caused by birds, fruit fly, wind, oidium, botrytis, berry cracking and particularly the squashing of berries in compact bunches are all important infection points for acid rot fungi. It was found that chemical control is impractical for various reasons and that control should be aimed at the prevention of wounds.

It was also found that vinegar flies, generally associated with acid rot, are not the cause of the

disease and the chemical control of vinegar flies is therefore unnecessary.

The die-back disease in vineyards known as tandpyn probably causes greater losses in the industry than any other disease. There are indications that two fungus species are involved in this disease complex, i.e. *Eutypa lata* and *Cryptovalsa ampelina*, of which *E. lata* is the more pathogenic fungus. A saprophytic bacterium which suppresses both fungi *in vitro* was isolated from vine wood during investigations. Trials are currently being conducted to determine the potential of biological control of this bacterium in the field.

Fertiliser

The fertiliser requirements of grape vines were tested over 11 years in a long-term field trial with Chenin Blanc on a representative soil type at Stellenbosch. The application levels of N, P and K were compared in respect of shoot growth, production, leaf and must analyses and wine quality.

Although all three elements positively influenced shoot growth and production, not one of the fertiliser treatments increased production by more than about 6%. This was an indication that the fertiliser requirements of vineyards in the Stellenbosch area in which grapes are cultivated for the production of quality wine (a yield of 10 to 15 ton/ha) are relatively small. The findings of this trial have already been incorporated in the fertilisation guide-lines for vineyards.

Soil compaction

Soil samples from different vine-growing areas were used for soil compaction studies. Comprehensive soil-physical analyses were carried out on all the samples and two computer models were tested for their ability to predict the compactibility of soils on the basis of textural data. This research has made it possible to carry out compactibility studies of soils on a routine basis.

Irrigation/cultivation

Combinations of irrigation and cultivation methods were tested in a vineyard in Oudtshoorn, with a view to the conservation of water in particular. Gravity irrigation saved more than 50% of irrigation water in comparison with conventional full surface flood irrigation without detrimentally affecting vineyard performance. However, the irrigation frequency had to be increased from 21 days to 14 days, since a smaller soil volume was being wetted. Drip irrigation on these deep, fertile soils has no advantages over gravity irrigation.

It was once again proved in this trial that conventional clean cultivation destroys the soil structure in the long term. After five years the shoot growth began to decrease and after seven years the production of the clean cultivation plots also began

to decrease. In contrast, minimum cultivation with the help of a mulch led to optimum water utilisation as a result of water conservation and better water infiltration.

It was also shown that a cover crop mat of about 5 tons of dry material per hectare keeps the vineyard weed-free during the summer months and therefore makes the use of pre-emergence weedkillers unnecessary.

The results of this trial therefore give the vine farmers of the Little Karoo the chance to save scarce irrigation water using simple management practices without detrimentally affecting the production and quality of wine grapes.

Oenology

Wine chemistry

Trials have shown that wines of a higher quality can be prepared by subjecting the must of white grapes to skin contact. Gewürztraminer musts were subjected to skin contact for 4, 15 and 20 hours at 0 °C and 20 °C. Wines prepared after low temperature skin contact were generally of a higher quality than wine prepared from free run must and musts that were subjected to skin contact at high temperatures.

A high grape temperature during pressing followed by skin contact results in more bitter wines than in the case of cooler grapes. A phenol fraction in wine, which can serve as an important indicator of bitterness, was identified.

Wine microbiology

More light was shed on the taxonomy of *Leuconostoc oenos*, the organism responsible for malolactic fermentation in wines. After studying the cellular fatty acid profiles of 54 *L. oenos* races, four races were transferred to the new species *L. gracile*. After studying the reaction of the 54 races at various ethanol and SO₂ levels and their temperature and pH sensitivity, four races were selected for use in inducing malolactic fermentation in wine.

The relationship between ergosterol, totally unsaturated and totally saturated fatty acids, and sugar fermentation at 10 °C, 15 °C and 20 °C, were investigated. No relationship was found to exist between ergosterol and total unsaturated fatty acid concentrations and the specific fermentation rates of the selected yeast races. However, the high specific fermentation rates of the yeast races correlated well with high total saturated fatty acid concentrations. This finding is in conflict with the current view that high concentrations of unsaturated fatty acids increase ethanol tolerance and therefore provide better fermentations.

The fermentation rates of four commercial dry wine yeast races were influenced in different ways by an increasing nitrogen concentration in must. Higher nitrogen concentrations increase fermentation rates,

but no difference could be found between the effect of diammonium phosphate and the effect of a much more expensive commercial yeast food.

Citrus and subtropical crops

Citrus

Crop science - In the field scion research the emphasis was on new cultivar expansion in particular. Intensive breeding was aimed at citrus cultivars that are easy to peel. At Malelane 435 crosses have already been established and at Addo 1 120.

Efforts to make high priority cultivars virus-free continue and up to now 184 cultivars have been made virus-free with the use of growth point grafting.

Good progress is being made with a new approach to rootstock research, i.e. an extended evaluation programme. Plantings at Malelane and Messina already include more than 160 rootstocks each. The best rootstocks will be identified by a process of elimination.

Nursery research has led to the identification of the optimum shade requirements of the citrus nursery trees in the Malelane area. The use of 40% shade net produced the most rapid growth rate and led to a water saving of more than 40%.

Pests - Four pesticides seem to be effective in the control of the Lowveld citrus mite, *Eutetranychus orientalis*. It is therefore recommended that these pesticides should be registered for the control of this type of mite.

Various predators of the citrus psylla, *Trioza erytreae*, were recorded. Predators make a contribution to the decrease of citrus psylla populations, but they are not able to limit the populations to economically acceptable levels.

Population surveys of the white powdery scale insect (*Cribrolecanium andersoni*) have indicated that there are three to four generations per annum. The parasitoids *Euxanthellus philippiae* and *Coccophagus pulvinariae* were identified. Spraying with chlorpiriphos and mineral oil gave good control over the scale insect.

Two chitin synthesis inhibitors are now registered for the control of the false codling moth. In the Citrusdal area it was shown that the correct release of egg parasites can result in a decrease of up to 80% in crop losses. The best results were obtained during the first half of the season.

Plant nutrition - A new approach to the interpretation of leaf analyses of Valencias was investigated and tested over a period of six years. This approach specifically deals with the ratio of N:K, with the qualification that the concentration should be higher than 18 g N/kg of dry matter and that K should be higher than 9 g/kg. For optimum crop size the ideal N:K ratio lies between 2,4 and 3,0 and optimum fruit size can be obtained with a ratio of 1,6 to 2,2.

The result of this new approach is that a wide range of N and K concentrations can be optimum as

long as the ratio is correct.

This promises to facilitate considerably the optimum fertilisation for citrus, particularly Valencias and mid-season oranges.

Diseases - One of the dwarfing factors inoculated to citrus reduces the tree size by 70% over four years while maintaining normal yield in relation to canopy size and having no effect on fruit quality.

Pineapples

Plant physiology - The techniques for the rapid propagation of pineapples by tissue culture have been completed to the point where commercial laboratories are now in a position to use the method with confidence.

Diseases - Somaclonal selection of tissue-cultured pineapples for resistance to *Phytophthora* has turned up a surprisingly high number of resistant plants and selections of these will be field tested.

Bananas

Crop science - After three crop cycles of a large randomised cultivar trial at Burgershall the imported cultivars Grand Nain, Valery and Chinese Cavendish proved superior to the normally recommended Williams in terms of yield and other horticultural characteristics. These three cultivars have been provisionally released to the Banana Board for further commercial evaluation on farms.

A technique for early crop forecasting of Williams bananas was developed at Burgershall and Levubu. A computer program was written and it is now being commercially evaluated by the Banana Board.

In a desuckering trial at Burgershall there was an 18% loss in yield/annum as a result of leaving unwanted suckers to grow to 800 mm, compared with early removal at 300 mm. There was an overall 6% yield reduction as a result of leaving an extra sucker per plant which was later excavated for replanting purposes.

Diseases - The Banana Board has funded a Panama Disease Research Unit. The research strategy adopted is the selection of somaclonal variants for resistance to Race 4 of the disease.

Pests - Oxamil applied in the leaf bases of banana plants is a cheaper and more effective method for the application of nematicides in banana plants. A significant reduction in nematode numbers was obtained in this way. The banana cultivar SH 3362 appears to be more tolerant of burrowing nematodes than the Williams and Dwarf Cavendish cultivars.

Technology - Research done by the Fruit and Fruit Technology Research Institute has shown that controlled atmosphere storage (1% oxygen and 7% carbonic acid gas) at a temperature of 13°C can lengthen the storage life of bananas from 14 days to 56 days. Ethylene considerably increases the rate of ripening and should be removed from the

atmosphere. The degree of ripeness is also of importance since bananas that are slightly riper than those next to them initiate ripening and give rise to quality loss during the long storage period.

Avocados

Plant physiology - A technique for rapid propagation of green leafy avocado cuttings, normally very difficult to root, was developed using a technique of plant growth regulator manipulation. This technique will save considerable time and expense and could revolutionise the propagation of hardwood cuttings.

The mechanisms involved in the development of fruit physiological disorders were found to be closely related to water stress, both pre-harvest and post-harvest. Humidification of cold rooms and containers will decrease the quality problems found after transportation of avocados to Europe.

Diseases - Scanning electron microscopic studies of the interactions of *Phytophthora* zoospores and avocado roots have shown differences in the interactions of resistant and susceptible cultivars which may help in the selection of resistant rootstocks.

Technology - Avocados react well to controlled atmosphere storage. This almost completely prevents cold damage and enzymatic browning of fruit tissue. It is possible to store fruits for four to five weeks at 5.5°C without it losing quality. However, it is difficult to apply controlled atmosphere storage in practice because ships and other means of transport are at present not equipped with gas-tight spaces which can maintain the required gas concentrations.

Research done by the Fruit and Fruit Technology Research Institute has shown that the same results are obtained when avocados are treated immediately after harvest for a few days with a high concentrate of carbonic acid gas. This treatment considerably lowers the risk related to exports by sea and is therefore of great value for the avocado industry.

Mangoes

Improvement - Ten new cultivars were imported from Mauritius to enlarge the already existing gene bank. The breeding and selection programme is progressing well and provisional protection of plant breeders' rights was obtained for four new cultivars.

Physiology - Flowering delay trials showed that irrigation with dinoseb acetate might possibly be beneficial to the industry. However, it can only be beneficial if temperatures drop below 8°C during flowering time. The time of initiation and the length of time of differentiation of Haden and Sensation flower buds were investigated in three production areas. The results make a valuable contribution to research on the pruning of mango trees by means of which tree size and harvest time can be manipulated.

Pests - The mango scale insect is responsible for inadmissible blemishes on the skin of export

fruits. Provisional results indicate that mineral oils can safely be used against scale insects on mango trees provided they are sprayed shortly after fruit set and that the trees are not subject to drought stress.

Guavas

Improvement - From more than 1 000 seedlings five were identified as very promising. Provisional protection of plant breeders' rights was obtained in respect of these five selections and applications for their registration as new cultivars have already been submitted.

Diseases - A very promising selection of Fan Retief that is tolerant to guava wilt disease has been found and will be tested on a large scale.

Granadillas

Crop science - The Citrus and Subtropical Fruit Research Institute is still of the opinion that the red granadilla (*Passiflora caerulea*) can be successfully used as a rootstock because further pathological tests have proved its tolerance to root diseases. However, the rootstock is not resistant to nematodes.

Coffee

Pests - It would appear that the antestia bug has 9 generations per annum. Six egg parasitoids and one possible secondary egg parasitoid of the antestia bug were identified. A coffee berry borer, *Araecerus fasciculatus*, was found.

Tea

Plant physiology - Research into the factors affecting the quality of South African tea has shown that the final chlorophyll content in the factory product is of vital importance. This work may lead to a change in management techniques.

Ginger

Pests - Methyl bromide applied according to the hot gas method resulted in crop improvements of 53%. This agent also controls weeds and leaf spot. There are differences between the performance of the various agrotypes if they are cultivated on soil that is heavily infested with root-knot nematodes. Differences were also observed in the tolerance of the agrotypes to *Nigrospora* leaf spot.

Nuts

Macadamia nuts

Crop science - Evaluation work over the past 18 years with promising local and overseas cultivars has shown that some of these cultivars can be

economically grown in the Southern Lowveld and the Levubu area of the Soutpansberg. New cultivars and selections are still being imported and selected to improve on existing cultivars.

Diseases - *Phytophthora* was found to be extensively distributed in macadamia plantings and it was found that Hawaiian cultivars are more tolerant of the disease than the Nelmac cultivars.

Pecan nut

Plant nutrition - In long-term field trials it was found that the leaf analysis norms for young pecan nut trees (younger than 11 years) differ from those of older trees, particularly with regard to nitrogen. For optimum production a leaf N status of 25 to 26 g N/kg is recommended for young trees and 25 to 29 g N/kg for older trees. According to the trial results, it was clear that if the N status of the leaves of older trees is within the optimum range, little or no nitrogen fertilisation is necessary.

A reaction to P or K applications, in terms of production, can be expected only when the P status of the soil is lower than 23 mg/kg and the K status lower than 68 mg/kg. Optimum leaf composition for P is between 1,3 and 1,4 g/kg and between 11,2 and 13,0 g/kg for K.

Vegetable crops

Potatoes

Improvement - The most significant problems in the potato industry remain low production per unit of area, poor quality and keeping capacity and the ineffective utilisation of soil moisture. The erratic dry land production and the lack of genotypes with a tolerance for high temperatures and for diseases such as corky scab, fusarium and bacterial wilt disease can be regarded as the main reasons for the problems.

Progress is being made with the development of improved genotypes. The first evaluation trials for the investigation into the heritability of heat tolerance are to be planted during the spring of 1988, after the successful crossing and propagation programme. The semi-commercial evaluation scheme is aimed at evaluating the market acceptability of new cultivars and advanced breeding lines in various areas. The scheme is progressing well and three breeding lines for which applications for introduction have been made, have already been planted at 8 of the 16 subevaluators.

Physiology - For the first time plants were regenerated from single-cell cultures and evaluation of the plants and selection for useful mutations is now receiving attention.

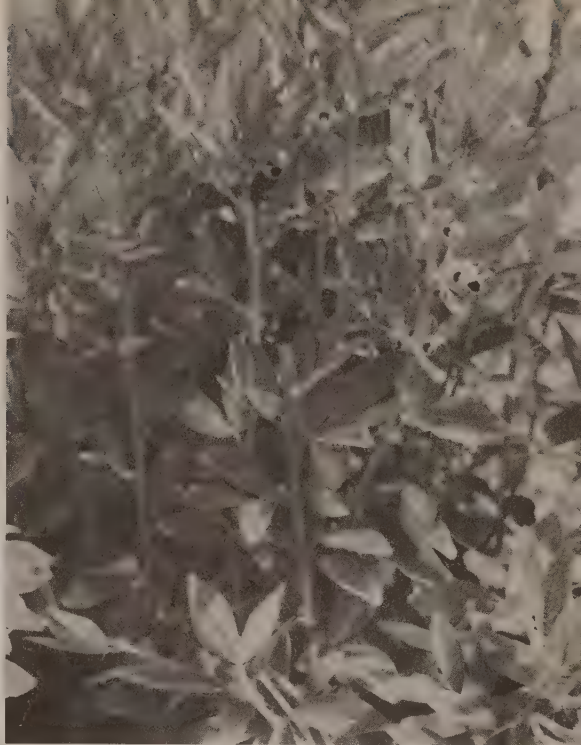
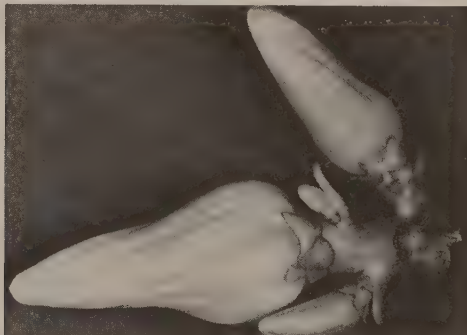
Crop physiology - The investigation into the influence of calcium applications on the keeping capacity of potatoes under controlled conditions was completed and is being extended into practice.

Pathology - Antisera against both a foreign and a local isolate of potato leaf roll virus were



Controlled crosses in pears are done by hand

The papaya inflorescence which is sympodial and tends towards a cluster

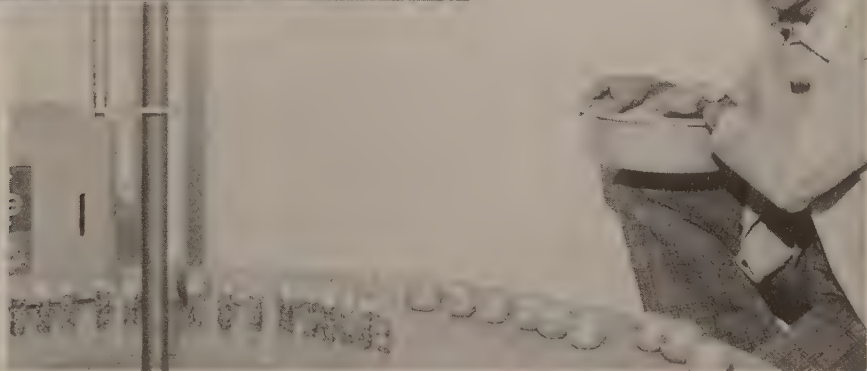


Faba beans are well adapted to the greater part of the Winter Rainfall Region and should be an excellent rotational legume crop for lupins



Copper kettles are used to distil experimental brandy

Apples and other deciduous fruit are subject to fruit-fly infestation. Gamma irradiation was investigated as a possible quarantine treatment for export apples



prepared and are currently being used in the ELISA technique in order to trace the virus successfully.

During a survey on bacterial wilt disease, biovar 2 was isolated mainly from infected potato plants and biovar 3 mainly from tomato and tobacco plants.

A further important finding is that infected plants cultivated at low temperatures do not necessarily develop symptoms and that the disease can therefore be passed on unnoticed in this way by infected tubers.

Eight *Fusarium* spp. and *Gliocladium roseum* were positively associated with dry and stem end rot in potatoes, of which *F. oxysporum*, *F. crookwellense*, *F. solani* and *F. sambucinum* were the most pathogenic species.

A quick and effective technique was developed to determine, both quantitatively and qualitatively, the absolute inoculum potential of the *Fusarium* dry rot pathogens in the soil.

Silver scurf and anthracnose are found in all potato production areas and are a more serious problem than was originally thought.

Tomatoes

Improvement - The multi-resistant market tomato cultivar Rotam 3 was placed on the cultivar list in addition to the two canning tomato cultivars Rotam 1, a nematode resistant line, and Rotam 2, a bacterial wilt disease resistant line. The two locally bred cultivars Rodade and Stevens again compared favourably with all the other cultivars, while some of the canning tomato breeding lines gave better yields than the standard cultivar UC 82B.

Irrigation - The extent to which canning tomatoes can absorb water from the soil, measured according to laboratory methods, is underestimated. The plants are able to absorb large quantities of water from the deeper soil layers without significantly reducing their yield. Reliable guide-lines for the measurement of leaf water potential were determined and may be used for further irrigation research.

Pests - The effective control of root-knot nematode during the earlier growth stages of the crop is essential. Later nematode infestations do not seem to reduce the yield significantly.

The leaf miner (*Liriomyza trifolii*), which was known to be found in Natal, the Transvaal Lowveld and the area of Brits, has now also been found in the Gamtoos Valley and the western Cape Province. Research on biological control with the use of parasites continues.

Pathology - The method of determining the resistance of tomatoes to bacterial canker was again tested in the field. The technique is currently also being used for the selection of bacterial canker resistant tomato breeding lines.

Rotam 4 was found to be resistant to all the South African isolates of the pathogen which causes bacterial canker (*Corynebacterium michiganense* pv. *michiganense*), that have been tested up to now.

It was determined that in addition to Race 1, Race 2 of *Verticillium dahliae* is also found in South Africa.

Onions

Improvement - Short-day male sterilised lines were developed and evaluated. Some of these lines are very early, but their bulb quality must first be improved. Advanced medium-day onion lines were also developed for use as parents in an F1 crossing programme.

Crop science - The results of spacing trials at Elsenburg indicate that rectangular layout has no influence on yield, bulb form or bulb mass. Yield and the percentage of small bulbs increased with plant population, while the percentage of large bulbs sharply decreased and the percentage of medium bulbs remained constant. Therefore the optimum plant population had to be determined as regards the yield of medium onions, bulb form and bulb mass.

Pathology - One commercial cultivar was found to be resistant to South African races of the pathogen which causes pink root (*Pyrenochaeta terrestris*).

Cauliflowers

Improvement - Two early cauliflower breeding lines are being submitted to the cultivar committee for approval as candidate cultivars on the basis of good results with cultivar trials in the various production regions. The crop period of the one cultivar ranges from 55 to 90 days after planting and that of the other from 60 to 85 days.

Carrots

Improvement - Two fresh market carrot cultivars, Cape Mark and Chantenay Karoo, were developed by breeding to a degree of type veracity acceptable to the Plant and Seed Control Directorate.

Crop science - Cultivar trials with carrots were carried out in various production areas. At Roodeplaat and Glen, Cape Mark and Kuroda gave the highest marketable yields and Kuroda and Fancy performed the best at Addo.

Sweet potatoes

Improvement - The breeding programme produced five promising lines suitable for fresh marketing and two lines with the required form and low oxidation tempo for quick freezing. If these lines perform well in evaluation trials, they will supplement the shortage in the processing industry in respect of lines with a low oxidation tempo. The possibilities of starch production from sweet potatoes seem promising with the acquisition of a line which produces 30% starch. This high starch quality should now be combined with good production quality.

Crop science - Two advanced lines performed better than the standard cultivars in the evaluation trials at Addo and Glen. At Roodeplaat three breeding lines showed great promise and they can be evaluated in the coming season in other areas.

Pathology - Fusarium wilt disease, caused by *Fusarium oxysporum* f.sp. *batis*, was identified and is beginning to be a problem for growers of runners.

Green beans

Improvement - Two white and two mottled green bean breeding lines with a high degree of resistance to fat fleck disease and brown rust were accepted by the cultivar committee as candidate cultivars. A white-seeded mutation of the black-seeded green bean cultivar Wintergreen was registered as the candidate cultivar Rowit.

Green peas

Improvement - Thirty-two powdery mildew resistant lines with good yield and quality were selected. The best will be able to be released as new cultivars. These cultivars will be particularly beneficial in the northern production areas where powdery mildew is a production problem.

Crop science - Stampede and Bikini, two new semi-leafless cultivars, fared well in a cultivar trial at Roodeplaat in respect of grain colour and yield. In a trial at George five advanced breeding lines gave a significantly better yield than the standard cultivar Small Sieve Freezer.

Dried peas

Improvement - Resistance to powdery mildew was passed on from the green peas to the dried peas without loss of dried pea quality. Crosses were made between this material and lines which remain upright until harvesting. Eight other promising advanced lines were selected for Phase 2 evaluation trials.

Crop science - The yellow seed cultivars Birte, Ropi and Miranda did well in a cultivar trial at Roodeplaat, but did not vary significantly from one another. The new semi-leafless green-seeded cultivar Salara also performed well and was 10 days earlier than the green-seeded cultivar Finale. Salara is therefore now the only available early green-seeded dried pea.

Pumpkins

Improvement - Two Platwitboer type pumpkin breeding lines with a stem growth were registered as the candidate cultivars Minette and Miniboer. Minette bears 10 to 12 pumpkins of 500 g each per plant, while Miniboer bears six to eight pumpkins of 1 kg each per plant. These cultivars are ready for harvesting 40-50 days earlier than Platwitboer and can be planted at much higher plant populations.

Consequently they produce up to double the yield of Platwitboer. A further advantage is the fact that stem pumpkins can be planted in such a way that mechanical cultivation between the rows is possible.

Crop science - Cultivar trials with pumpkins were carried out at Roodeplaat, Elsenburg and Addo. The new cultivar Rovaal performed well at all the localities, with yields of more than 40 tons per hectare.

Flowers and ornamental plants

Flowering bulb plants

Improvement - Breeding programmes are being carried on *Lachenalia* (violets), *Ornithogalum* (chinkerinchees), *Gladiolus* and the Amaryllidaceae (*Amaryllis* family).

Lachenalia - The applications for a further 17 selections for plant breeders' rights were completed and they are currently being released. Breeding is aimed at combining certain types of flowers with a particular colour which it has not been possible to obtain up to now. The determination of the presence of B chromosome in *Lachenalia* explained why chromosome numbers vary in a species. It was also found that *Lachenalia* pollen cannot be stored longer than a month at room temperature, whereas it can survive for 12 months at low temperatures, i.e. in a refrigerator ($\pm 5^{\circ}\text{C}$) and in liquid nitrogen ($\pm -160^{\circ}\text{C}$).

Virus-free bulbs of the cultivars and selections are propagated and maintained *in vitro*.

Ornithogalum - Crosses made with a view to breeding an orange-coloured *Ornithogalum* cut flower, showed that *O. dubium* should be used as the female parent and *O. thyrsoideus* as the male parent for the cross to succeed.

Gladiolus - With the aid of cytogenetic information obtained from *Gladiolus*, various other thoroughly planned crosses were made in order, among other things, to utilise important characteristics such as scent. Six *Gladiolus* selections, some of which are scented, are in the process of virus cleaning and bulb propagation and some of them will be offered for release as new cultivars as soon as possible.

Sources of resistance to brown rust were found and are being used in the breeding programme. Fungicides which effectively control brown rust were identified.

Amaryllidaceae - A new breeding programme was started for the *Amaryllidaceae* with the aim of breeding inter-species as inter-genus hybrids. A few crosses were successfully bred and seedlings were established during the first year. The first crosses are expected to begin flowering in three years time.

Crop science - It was found that the optimum storage temperature of bulbs and capacity for vegetative propagation in *Lachenalia* is cultivar related.

Nutrition studies in *Ornithogalum* and *Lachenalia* have shown that bulb plants are very

dependent on adequate nutrition for optimum flower and bulb production.

A tissue culture technique for the rapid propagation of *Lapeirousia silenoides* has been developed. Good progress has also been made with the development of techniques for *Amaryllis belladonna* and *Crinum* species.

Roses

It was determined that the best yellow rose cultivars that can be cultivated under shade net as cut flowers are Johannesburg Sun and Pamela.

Proteas

Improvement - The 10 new protea cultivars that were presented by the Vegetable and Ornamental Plant Research Institute to the South African Nature Foundation this year are a milestone in the protea industry.

The Department of Agriculture and Water Supply has entered into an agreement with the Nature Foundation to deal with the important intermediate step of testing and propagating on behalf of the protea industry. This work is carried out on a protea farm outside Stellenbosch.

Crop science - A method has been developed for extending the flowering time of export proteas and a method by means of which protea seed can be germinated with great success.

Other horticultural crops

Guayule

Crop science - The practice of harvesting the plant's upper growth with a view to harvesting the regrowth again after a few years produced lower yields than a single harvesting. The dry mass of the upper growth and of the roots harvested were both higher in the single harvest. The transplanting of older plants is of no benefit with regard to survival and the best time of the year to transplant differs from clone to clone. It seems that the herbicide oxyfluorfen will be the most suitable for weed control.

Chicory

Improvement - Descendants of the Grootfontein lines, i.e. lines that were bred in the Karoo region and the Eastern Cape region, were selected at Addo and the selected roots planted at Grootfontein in Middelburg, Cape.

Pathology

Black root rot: Wixor was the most resistant locally grown cultivar evaluated in respect of *Thielaviopsis basicola*, one of the organisms which causes black

root rot. Existing agents for the control of *T. basicola* did not control black root rot either in the fields or in glasshouse trials.

Stubby root: It was determined that stubby root is not only caused by nematodes and *Fusarium oxysporum*, but also by *T. basicola* and probably *Phytophthora* and *Rhizoctonia*.

PLANT PROTECTION RESEARCH

Plant pathology/ Microbiology

Mycology and plant pathology

National collection of fungi - This collection contains 49 155 specimens at present. 307 accessions were incorporated into the collection, which represents an increase of 8% as against the previous year. Eight national and two international loan applications were received and 119 specimens were issued for this purpose.

Preparations for the creation of a computerised data base for the collection have been completed.

Donations of two collections of fungi were received during the past year; these were the prestigious Van der Bijl collection from the University of Stellenbosch and a miscellaneous collection of fungi from the Bolus Herbarium of the University of Cape Town.

National culture collection - This collection was enlarged by 549 cultures, to approximately 4 500 cultures. A computerised list of available genera and species was drawn up, which makes it considerably easier to deal with enquiries from outside bodies.

A collection of 158 cultures was donated to this unit by the Department of Microbiology of the University of Cape Town for inclusion in the National Culture Collection.

Identification service - Approximately 388 isolates were identified for researchers attached to 11 institutions. Several of these isolates (chiefly Coelomycetes) are of taxonomic value and are undergoing further study.

In co-operation with Onderstepoort, 74 feed samples were investigated for possible toxigenic fungi. 42 maize samples were investigated for the presence of *Stenocarpella maydis* and *Fusarium* spp., in co-operation with the Maize Board and the Animal and Dairy Science Research Institute. Over 4 000 isolates of the species concerned were identified.

The mycology unit provides a specialised service, of which research bodies are increasingly availing themselves. The donation by universities of important collections of fungi to this unit is evidence of the status it enjoys. Since taxonomic research within the unit is directed at economically important groups, researchers can be given support over a wide field.

Phytophthora root diseases - Rivers of the

southern coastal region of the Cape Province were sampled for *Phytophthora* spp. during 1984 to 1987. Four species which cause diseases of crops grown in this region were recovered. Native vegetation apparently serves as an important source of *Phytophthora* spp. in rivers used for irrigation in this region.

Major crop losses of sweet lupins in the south-western Cape Province during 1986 and 1987 were investigated and were found to be caused by a new *Phytophthora* root disease. In preliminary tests under controlled conditions, seed treatments containing metalaxyl gave good control of the disease.

A root rot of *Anthurium* was investigated in the cut-flower trade and found to be caused by *Phytophthora nicotianae*. A technique using electrophoresis of soluble proteins linked to numerical taxonomic methods is being developed as an aid in the identification of various fungi, especially the genus *Phytophthora*.

Rhizoctonia seed and hypocotyl rots - From studies on 18 isolates of *Rhizoctonia solani*, each could be classified either as virulent, causing seed rot and severe hypocotyl disease, or as weakly virulent causing a less severe hypocotyl rot and no seed rot on *Phaseolus vulgaris*.

Fungal diseases of pasture legumes - Root rot of annual *Medicago* spp. (medics) is widespread in the winter rainfall region of South Africa. Significantly more root rot was recorded in fields established after only one-year rotation than in fields established after two or more years' rotation with a cereal crop.

Several *Colletotrichum* spp. were distinguished on lucerne (*Medicago sativa*) such as *C. coccodes* and *C. truncatum* which had not previously been recorded on lucerne in South Africa. *C. trifolii* was the most pathogenic species, causing *Colletotrichum* crown rot and anthracnose of lucerne.

A partially selective medium for isolating the slow-growing *C. trifolii* from lucerne tissue was developed. Of 19 lucerne accessions tested under greenhouse and field conditions, S.A. Standard was the most resistant to *Colletotrichum* crown rot and one of the most resistant to anthracnose, but it also gave the lowest yield.

A field guide to the identification of lucerne diseases was brought out for farmers and extension officers.

Forest tree diseases - *Sphaeropsis sapinea*, which causes serious shoot blight and death of pines after hail, has been shown to induce a range of variants which may explain differences in pathogenicity under different circumstances. Studies have been conducted on the dispersal of this pathogen in all three climatic regions of South Africa. Results indicate that winter is the most desirable time to prune pine trees in order to avoid infection of pruning wounds by *S. sapinea* conidia.

The introduction of clonal propagation of *Eucalyptus* in South Africa has raised concern that foliar pathogens will cause significant epidemics of these trees in future. In a preliminary survey of

Eucalyptus leaf diseases two previously unrecorded pathogens, *Phaeoseptoria eucalypti* and *Coniothyrium ovatum* were found. Numerous other leaf pathogens also appear to be present in the country and diseases by them deserve urgent attention.

Virus diseases

Because closterovirus Type III appears to be an essential component in naturally and mealybug (*Planococcus ficus*) transmitted leaf roll disease, studies are in progress to develop an ELISA test for virus type in kit form for industry.

While continuing with the survey of the viruses of soyabeans, five further isolates of soyabean mosaic virus were identified, along with the identification of three isolates of peanut mottle virus. This is the first report of this virus in South Africa. It was prevalent in the Groblersdal soyabean producing area, where some fields were infected in excess of 60%. Peanut mottle virus is not seed-transmitted in soyabeans, but is known to be able to cause serious yield losses in this crop. The virology unit is currently screening a number of cultivars for resistance, including the more widely planted South African cultivars.

A survey on the viruses of beans and lupins was also launched. On beans numerous isolates of bean common mosaic virus, bean yellow mosaic virus, peanut mottle virus and an unknown virus were obtained.

On lupins numerous isolates of bean yellow mosaic virus were obtained which appear to represent three strains.

Bacterial diseases

The disease-free dry bean and green bean scheme continued to receive high priority during the past year. Ten cultivars of pathogen-free dry bean breeders' seed were multiplied in greenhouses and dispatched to breeders for further multiplication under the supervision of officers of the Plant Protection Research Institute. A total of 13 plant and 412 seed samples were received and tested in the laboratory for the presence of bacterial diseases. The strictness of the control exercised is demonstrated by the fact that up to 25% of the samples are rejected and therefore cannot qualify as disease-free bean seed.

The bactericide zinc omadine was submitted for registration by the Department. This preparation will help to control the external contamination of disease-free seed.

196 plant and seed samples of other crops were also investigated for bacterial diseases. These included soya-beans, *Brassica* seed and guar. 56 pea samples were investigated. Various outbreaks of *Pseudomonas pisi* occurred in pea plantings, especially in the Northern Cape and at Groblersdal and Marble Hall. The outbreaks could be traced back to infected seed that had been used for plantings.

Biological nitrogen fixing

Researchers proceeded with the testing and selection of the most effective *Rhizobium* and *Bradyrhizobium* races for possible use in legume inoculants. Inoculant manufacturers were supplied with the best races and steps were taken to ensure that only high quality inoculants appeared on the market. Good progress was made with research on the inability of inoculant races to compete with indigenous rhizobia and with work on the mechanism by means of which various legumes and their respective rhizobia recognise one another. The promotion of inoculation with liquid inoculant where large areas are planted to cereal legumes has met with some success and good results have been achieved with soya-beans and especially with peas. Successful inoculation of the crops completely eliminates nitrogen fertilising.

During the past year 297 inoculants were prepared for 120 different legumes and made available to bodies wishing to use them to carry out trials.

Weed Research

Biological control of weeds

Lantana (*Lantana camara*) - The populations of the leaf-sucking bug *Teleonemia scrupulosa* increased tremendously towards the end of the summer and caused severe defoliation of lantana plants throughout Natal and the Transvaal.

The leaf-mining beetles *Uroplata girardi* and *Ocotoma scabripennis* were released in a number of new localities in the vicinities of Tzaneen, Magoebaskloof en Westfalia at the end of 1987. In Natal the insects are widely established and no further releases were made.

The leaf-mining fly *Calcomyza lantanæ* remains widely distributed in Natal and contributes significantly to lantana control in many areas.

Satansbos (*Solanum elaeagnifolium*) - Host specificity studies on *Leptinotarsa texana* and *L. defecta* for the biological control of satansbos showed that eggplant (*S. melongena*) and two native solanum weeds are acceptable hosts to these beetles under artificial rearing conditions. Neither of these beetles have been recorded from eggplant in their country of origin (Texas).

Prosopis (*Prosopis velutina* and *P. glandulosa*) - Host specificity tests showed that the seed-feedingbruchid beetles (*Algarobius prosopis* and *Algarobius bottimeri*), imported from Arizona (USA) and Texas, were host specific. The first beetles were released near Van Wyksvlei during December 1987 and first indications are that *Algarobius prosopis* has become established. Mass breeding and evaluation of this beetle continue.

Prickly pear (*Opuntia ficus-indica*) - Efforts to improve the techniques to mass rear *Dactylopius coccus* under roof cover on prickly pear leaf pads continue. These techniques and breeding stock of the insects are now made available to entrepreneurs who wish to produce carminic acid (red dye) for export.

Paraffin/Triffid weed (*Chromolaena odorata*) -

A biological control programme on this weed has been started. Early in 1988 an exploratory trip was made to South America during which a number of promising biological control candidates, both insects and fungi, were identified and collected. These are now being evaluated.

Aquatic weeds - Population numbers of the beetle *Neochetina eichhorniae* on water hyacinth increased in all localities in the country where the beetle was released. The increase in beetle numbers in the western parts of the Crocodile River in particular was encouraging, and up to five beetles per plant were recorded. This is sufficient to inhibit the growth of such plants. After the abundant rains and the resultant floods, especially in the period following September 1987, water hyacinth populations decreased drastically in all the rivers where the weed occurs. *N. eichhorniae* is still present in the remaining nuclear infestations. An additional natural enemy of water hyacinth, the moth *Sameodes albigitalis*, has been imported and is still in quarantine. The beetle *Cyrtobagus salviniae* is still providing good control of *Salvinia molesta*. The water lettuce beetle *Neohydronomus pulchellus* has also been released on water lettuce in the Sabie River and has established itself.

Sesbania (*Sesbania punicea*) - During the year under review researchers continued to distribute the seed beetle *Rhyssomatus marginatus* and the stem borer *Neodiplogrammus quadrivittatus* in the northern areas of the RSA where the bud-weevil *Trichapion lativentre* is already well established. These two additional insect species are considered necessary to deal the final blow to the sesbania infestations.

Crofton weed (*Ageratina adenophora*) - A fungus leaf pathogen, *Phaeoramularia* sp., was imported from Australia. Following specificity testing on closely related indigenous and introduced plants, the fungus was released in Natal and the south-western Cape.

Bugweed (*Solanum mauritianum*) - A collection trip in north-eastern Argentina and south-eastern Brazil in 1987 yielded a large variety of natural insect enemies. These were reared to allow identification and six species were selected for further studies. However, many other candidates remain to be identified and studied.

Australian Acacia weeds - Research on the gall wasp *Trichilogaster acaciaelongifoliae*, introduced to control the weed *Acacia longifolia*, has been rounded off. During 1987 the last data were collected which confirmed that the wasp is extremely effective in all regions but the drier, hotter inland valleys of the south-western Cape Province.

The weevil *Melanterius ventralis*, released on *Acacia longifolia* in South Africa to reduce the seed production of this weed, has been established at five study sites in the south-western Cape Province. Populations of the weevil are increasing and at one site up to 40% of the seeds have been destroyed.

The seed weevil *Melanterius acacia*, released on *Acacia melanoxylon* at seven study sites in the

southern Cape where this plant is most invasive, has become established and data regarding seed destruction are being accumulated.

The first galls have developed on *Acacia saligna* plants at the sites where the gall-rust fungus *Uromycladium tepperianum* was first released in 1987 in the south-western Cape.

Hakea (*Hakea sericea*) - Field trials with a wheat bran formulation of a strain of the fungus *Colletotrichum gloeosporioides* resulted in 98% control of seedlings of this invasive weed.

Chemical control of weeds

Satansbos (*Solanum elaeagnifolium*) - Preliminary results of two spraying trials at Kendrew and in the Free State confirm that virtually all the preparations produced a reduction in the number of bitter apple stems after a second seasonal application. At this stage the results are disappointing, as they have been elsewhere in the world. It certainly appears that silverleaf bitter apple, with its deep branching root system will not be easy to destroy, even with repeated doses of herbicide.

Prosopis (*Prosopis velutina* and *P. glandulosa*) - Numerous herbicides have been tested for the control of *Prosopis*. All trials show that the most effective method of controlling *Prosopis* using herbicides is the cut-stump treatment. Winter treatments gave 95% control and are more successful than summer applications.

Paraffin/Triffid weed (*Chromolaena odorata*) - The registered recommendation of triclopyr ester applied to foliage has been reduced from a concentration of 0,5% to 0,375% in water. The application of 1,0% triclopyr ester in diesel and 1,5% imazapyr in water to stumps has been registered.

Pereskia (*Pereskia aculeata*) - No herbicide has yet been found to kill the plants completely. The ester formulation of triclopyr with a suitable adjuvant has been registered for top growth. This greatly increases access for manual excavation, which is the recommended follow-up for this species.

Pesticide dynamics

During the past year vegetable farmers suffered unprecedented losses in certain areas of Natal, especially in the Tala valley. The monitoring of atmospheric, rain and dew samples was continued at three points in the valley. Monitoring was also carried out on a sugar-cane farm outside the Tala Valley. After problems had been experienced in the Muldersdrift area of the Transvaal a monitoring station was established there as well.

According to the results, 2,4-D salts, MCPA and dicamba did sometimes occur in atmospheric samples. The incidence was low, however, being only 3 - 4% of the number of samples taken.

The concentrations found were about 0,000 000 100 g per cubic metre of air. It is intended to undertake research in Britain to determine whether these concentrations could be responsible

for phytotoxicity in vegetables.

The analysis of rainwater showed a higher incidence of 2,4-D salts, dicamba and MCPA. About 22% of the rainwater samples contained perceptible residues of these weedkillers. The concentration levels were around 0,000 1 g per litre of rainwater and, as might be expected, the concentration was higher with a low rainfall. The phytotoxicity of these residues in rainwater is being investigated at present.

An interesting aspect of the investigation is that all the herbicide residues were also found on the sugar-cane farm outside the Tala valley. This means that some of the herbicide drifts away during spraying. Methods of limiting this as far as possible will have to be found.

Pesticide application - The behaviour of spray on the leaves of various plants was investigated. It was established that certain physical properties of the spray liquid and the leaf surface can be determined both theoretically and by practical means. Consequently it is possible to predict the behaviour of a formulated pesticide in a spray on a particular plant. The advantage of this is that it becomes possible to improve selective weed control by modifying the physical properties of the spraying mixture through the addition of a particular adjuvant. It was also established that the wetting of leaf surfaces by a spray is affected by the age and environment of the leaf.

An anatomical study was also carried out to determine how the leaf surface is modified by environmental factors.

Technical advice (Act 36 of 1947)

Some 400 applications for registration or the amendment of existing registrations of insecticides, fungicides, rodenticides, plant growth regulants, algicides and adjuvants were recommended for registration. The registration of about 1 600 preparations was also renewed during the year under review.

The two Departmental guides, *A Guide to the Use of Pesticides and Fungicides in the Republic of South Africa* and *A Guide to the Use of Herbicides* were revised and appeared in the course of the second half of 1987.

Zoology/Entomology

National Collection of Insects

The keen demand for insect identifications continued during the year under review. Several thousand identifications of a variety of insects of economic importance were supplied to departmental researchers, to scientists from other institutions and to farmers and the public. Queries on entomological subjects are dealt with virtually daily, and in fact the demand for this service is increasing.

Specialised taxonomic research has been continued on the following groups: parasitic wasps,

solitary bees, snout beetles and leaf beetles, aphids and scale insects and Neuroptera (lacewings and closely related groups). Several taxonomic studies on these insects have been completed and the results summarised in seven scientific publications. These publications include a catalogue of the carpenter bees of Africa, a comprehensive revision of a group of parasitic wasps that are important for biological control and a study on a group of economically important snout beetles.

Insect surveys were carried out in various parts of the country and several thousand new accessions were added to the National Collection.

Biological and integrated control

American bollworm - Some 24 releases of the imported parasitoid *Cotesia kazak* have been made in five districts in the Transvaal on several crops. Since no recoveries have been made the research emphasis will shift to studies of release methods and further importations of *Cotesia kazak* and other natural enemies.

Stem borers - It was found in laboratory studies that the two borers, *Chilo partellus* and *Busseola fusca*, can overwinter in diapause without food or water. The intake of water, however, plays a major role in early termination of diapause in both species. Borer larvae that hibernated without water and emerged as adults during spring lost about 80% of their original mass. Field trials revealed that *Chilo partellus* is well established in the Delmas area on the Transvaal Highveld. This contradicts earlier reports that the borer is found only in the low-lying areas of the country. Complete destruction of stubble in winter was found to be an effective method of controlling stalk borer populations.

Quarantine service - Fifteen species of natural enemies were imported and cleared through quarantine in 9 consignments, serving four agricultural research institutions. In a novel undertaking a consignment of stem borers from Zimbabwe were reared in quarantine to determine which species were present, particularly whether the local sugar cane borer *Eldana saccharina* also occurred in the samples.

Spineless cactus pests - Trials using systemic insecticides to control cochenille and *Cactoblastis cactorum* have continued to be unsuccessful, largely because of phytotoxicity and erratic results. Previous reports that the insecticides registered for use against these pests are ineffective appear to be unfounded and largely due to poor application methods.

Insects in stored products

During 1987/88 a parasitic wasp of the tropical warehouse moth and the Indian meal moth was released weekly at the bag storage depot at Coalbrook. Numbers of the two moth pests were well controlled by the parasite and the method has practical possibilities. However, because the frequency of general fumigation was decreased on

account of this success, weevils, flour beetles and other beetle pests occurred early in 1988 and there was also an increase in damage to bags caused by rodents.

The use of parasitic wasps to control beetle pests and the application of the improved rodenticides that are expected to be placed on the market shortly are being investigated.

Work on the occurrence, nature and extent of *Trogoderma* and *Phradonoma* species in South Africa was begun. This group of insects are major pests of stored products, particularly in concrete grain elevators. The dreaded khapra beetle *Trogoderma granarium*, against which several countries apply quarantine measures, is a member of this group. Two collecting trips were undertaken and specimens of *Trogoderma* and *Phradonoma* species were collected at various depots.

Bee research

Research on the pollination of sunflowers by honey-bees has been completed and has now entered the extension phase. For effective cross-pollination of sunflowers (70-80% seed set) an average of one beehive per hectare is required during the flowering period. The practice of using bees to pollinate deciduous fruit is now well established in the Western Cape. Close liaison is maintained between the bee farmers, the fruit farmers and the honey-bee research unit. Fruit farmers value cross-pollination by honey-bees so highly that they are prepared to incur the expense of nocturnal spraying against pests in order to reduce mortality among the bees. Research has shown that pollination of pear trees should take place in two sessions, and this aspect is receiving concentrated attention in the extension effort.

An extensive review of Cape bee plants has been prepared and is being edited for publication. This publication will be of interest to bee farmers, park planners and any authorities who are interested in increasing the carrying capacity of the environment for honey-bees, especially in areas such as the Western Cape that are naturally poor in nectar.

Bitter honey was found in various part of the Transvaal; the cause was probably pollen from a *Bulbine* species (a type of lily).

The bee research unit again played a major part in the identification of adulterated honey, which is appearing in shops to an increasing extent.

A parasite of the eucalyptus nectar fly, an important competitor of honey-bees for eucalyptus nectar, has been discovered in Australia and imported. The parasite, a *Tetrastichus* species, which parasitises the larvae and pupae, has already been released from quarantine and two field releases against the nectar fly have been carried out in the Eastern Transvaal. The results are being studied at present.

Forest insects

The ecological approach to the control of insect pests in plantations is being continued. Attention is therefore being given to fundamental biological studies, especially with regard to biological control and tree breeding for resistance. Resistance is a function of the interaction between the genetic characters of the tree, the growth site, the climate and the silvicultural practices followed. Research on host-pest interactions between the black pine aphid and the pine woolly aphid revealed that on the same plot these two aphids prefer trees in different physiological conditions. In a sample of 6 000 pine trees an estimated 125 trees should have been attacked by both aphids. Not one such case was found, however.

Research on the biological control of the eucalyptus snout beetle, which has been controlled by biological means since the 1920s, was resumed. Only partial control is obtained by means of an egg parasite in areas situated above 1 200 metres above sea level since the parasite was not able to survive the cold winters in these areas. Parasites that appear to be cold-hardy have been obtained from Tasmania in order to improve biological control in higher-lying areas. Both an egg parasite and a larval parasite are being considered for release.

The biological control of the eucalyptus tortoise beetle by means of parasites imported from Australia is progressing very well. The egg parasite *Enoggera polita* is already found throughout the distribution area of the pest and the rapidity with which the eggs are being destroyed has led researchers to hope that this pest may have been arrested. A further three egg parasites are being kept in culture for release at a later stage.

Research on subterranean termites, which attack young eucalyptus plantations in Natal and the Eastern Transvaal, has centred around suitable treatments with insecticides. Chlordane, the only organophosphatic preparation it is still permissible to use, remains the most effective and the most economic preparation, but good results have also been obtained with more expensive preparations in granular form, which ensure controlled release of the preparation. Work on the biology of the termites has already begun.

The breeding cultures of timber insects have been concluded and all long-term research aspects, together with the insect cultures, have been handed over to the National Timber Research Institute of the CSIR.

Locusts

Spray trials - Trial work involving the use of the synthetic pyrethroids continued using more handy ground application equipment so as to establish initial dosage rates for aerial application. Although the pyrethroids *per se* have certain disadvantages (e.g. delayed mortalities), their outstanding knockdown properties appear to be advantageous. Combinations of deltamethrin and fenitrothion were

examined as possible toxicants for both brown and migratory locust.

Harvester termites

Field trials using baits were hampered by the unusually low level of termite activity during the winter of 1987. Nevertheless further testing of carbaryl formulated bait was undertaken in the north-western Free State and a further six trial plots were set out. Other candidate termite toxicants are being evaluated.

Foraging and food acceptance behaviour was studied in the field and the laboratory. In order to rate food acceptability within colonies a computer model has been devised which rates termite food in a more objective manner. Various sub-climax grass species from degraded areas in the field were compared as food for termites.

Similar examination on two of the commercially available bait carriers showed, surprisingly, that they were unacceptable to laboratory reared colonies. Research into more attractive substances to serve as carriers for baits seems to be indicated.

Economic acarology

The role of spiders as predators and the influence of chemical pesticide sprays on spider populations in irrigated cotton were investigated. Preliminary trials indicate that spider populations are more affected by spraying with alphamethrin than by spraying with endosulfan. It has been found that wolf spiders (family Lycosidae) are the most plentiful in cotton fields at the beginning of the season, whereas at the end of the season the commonest kind found are the sack spiders (family Clubionidae).

Effective pesticide application techniques for the control of agricultural pests in South Africa were investigated. Analyses indicate that despite programmes for the chemical control of agricultural pests annual crop losses are still in the order of 22%. The biggest yield losses are caused by weeds (R570 million), followed by insect and mite pests (R460 million) and plant pathogens (R400 million). However, the value of agrochemical remedies is underlined by the fact that it is estimated that crop yields in South Africa would be reduced to 35% of their present levels if the preparations were not used.

Unsatisfactory control of agricultural pests may be ascribed chiefly to ineffective methods of application. It has been calculated that with the equipment and technology available at present, spraying efficiency is only 65 - 70%.

National Collection of Arachnida - Mite accessions numbered 381 and spider accessions 900; 1 496 mite identifications and 3 421 spider identifications were carried out.

Economic zoology

The National Collection of Nematodes was expanded by 472 microscope slides, to 23 903 slides, which represents a total of about 86 500 mounted specimens. During the year under review 309 soil and root

samples were processed at the request of farmers and for the purposes of a potato survey and a lucerne survey. 104 mounted slides and bottles with preserved material for species identification were received. Taxonomic studies of the genera *Criconemella*, *Hemicycliophora*, *Xiphinema*, *Paratrophorus*, *Tylenchorhynchus* and *Meloidogyne* were continued and eight new species were described. A known species of the genus *Rotylenchus* was also recorded for the first time in South Africa.

South African plant-parasitic nematode survey - A computer program was created with the aim of drawing up an inventory of plant-parasitic nematodes that occur in South Africa.

Root-knot nematodes - Currently 115 single species populations of *Meloidogyne javanica*, *M. incognita*, *M. hapla*, *M. arenaria* and *M. chitwoodi* and 77 unidentified populations are in culture in the greenhouse. *M. hapla* can now be reared successfully on excised tomato roots in the laboratory.

Cytogenetic studies indicate that one cytological race of *M. javanica* (chromosome number $2n=42-47$) and two races of *M. hapla* (Race A chromosome number $n=15-17$ and Race B, chromosome number $2n=32$ and 36) occur in South Africa.

In host reaction studies *M. partityla* reproduced on roots of pecan nut seedlings, but did not attack tomatoes, beans, peas, cowpeas or peaches.

M. arenaria was identified in 23% of vineyard soil samples from the south-western Cape Province. *M. chitwoodi* was identified from potatoes at Boston and Mooi River in Natal and *M. javanica* and *M. incognita* from potatoes in the Middelburg-Bethal area.

New species of *Meloidogyne* and a related genus, *Meloinema*, have been described from indigenous vegetation.

ANIMAL PRODUCTION PROMOTION

ANIMAL BREEDING AND GENETICS

Blood typing service

During the year under review a total of 5 646 bovine blood samples were received at the Animal and Dairy Science Research Institute for blood typing and the determination of certain protein types. The compulsory tests for checking parentage remained constant at 525 cases, but parentage determinations were considerably lower, namely 234 as against 372 the previous year. Check tests carried out on semen used in the dairy breed bull progeny testing scheme showed that there is still a 23% error in parentages.

Full blood typing of 30 Merino sheep was carried out for the Elsenburg Research Station to determine whether there is any connection between the incidence of the crooked-leg syndrome in sheep and a specific blood and/or serum factor. This appears to be a possibility.

Cell genetics and biotechnology

Cytogenetic investigation of cattle from the Transvaal Highveld led to the discovery of chromosome translocation in the South African Simmentaler breed.

The importation of semen which may transmit chromosome anomalies or other undesirable traits is under investigation. By means of DNA probes it is possible to identify the presence of desirable or undesirable characteristics in semen.

After the initial success obtained with embryo transfer in sheep, it was decided to deviate from the standard surgical method to the latest non-surgical technique developed in France. The advantage of this method lies in the ongoing use of quality ewes. Surgical methods render the ewe incapable of further reproduction.

Sheep

Breeding - Breeding research on Karakul sheep in the Free State Region centres around the improvement of genetic breeding material in a black, brown and white Karakul stud. Breeding material in the studs is showing rapid improvement, and such material is expected to make an increasingly important contribution to the industry.

Reproduction - An investigation with Karakul ewes in the Free State Region revealed that somatic parameters (mass, condition and size) were not significantly related to reproduction. However, reproduction performance in the Karakul ewe is primarily determined by the nutritional level and it appears that high or low nutritional levels should be avoided immediately before and during mating.

Lamb production - In an attempt to increase the efficiency of lamb production in a semi-intensive production system, Romanov x Dorper ewes were evaluated at Glen. Although cross-bred ewes performed better than Dorper ewes in respect of lambing and weaning percentages, cross-bred lambs grew more slowly than Dorper lambs before and after weaning. The use of Ile-de-France rams with cross-bred ewes was investigated, with a view to improving growth. The result of this was that the poorer growth rate of cross-bred lambs was confined to pre-weaning growth and post-weaning growth was highly significantly better than that of Dorper lambs (254 as against 231 g/day).

Lamb mortality - An intensive investigation into the causes of high lamb mortality in the Winter Rainfall Region was carried out during the year under review by an Australian research colleague, Dr K.G. Haughey, in co-operation with local researchers. Difficult births and injury to the brain and spinal cord appear to be major causes. About 60% of the perinatal deaths were related to birth injuries.

It also became apparent that such injuries are related to the size of the ewe's pelvis. According to Australian findings, pelvis size is hereditary. It therefore appears that the weaning ability of an ewe can be used as a criterion when selecting against lamb mortality. Research on this subject is proceeding.

Horses

In order to prevent further inbreeding at the Elsenburg Percheron stud in the Winter Rainfall Region, semen donated by a French national stud was imported from France. It is intended to breed two new stallion lines.

Ostriches

A preliminary consignment of 25 unrelated wild type ostrich chicks was received from South-West Africa during the year under review. They will be used to broaden the genetic base of the Oudtshoorn ostrich population and possibly also for cross-breeding.

Accurate information was obtained by using sophisticated equipment to monitor the hatching temperature and humidity in natural hatching nests. Hatching success was improved by 50% as a result of the application of this information to the artificial hatching process.

Pigs

In an attempt at the Animal and Dairy Science Research Institute to elucidate the physiological mechanism by which the presence of a boar can

induce puberty in gilts, artificial stimuli were given to a number of prepubertal gilts. It seems that puberty cannot be induced by simply exposing the gilt to artificial stimuli.

NUTRITION

Dairy cattle

It was previously established that Phalaborwa vermiculite is not suitable as a rumen buffer in dairy cattle diets. A further finding is that vermiculite has no effect on protein, energy, starch or fibre digestibility and cannot serve as a buffer in the lower digestive tract of dairy cows.

Grazing - Kikuyu grazing under dryland conditions is the chief basis of dairy cow nutrition in large areas of the Eastern Cape coastal belt. The problem of low production is being investigated at the Bathurst Experimental Farm using dairy cows wearing bells so that the utilisation, availability and grazing periods can be estimated on pastures that have been rested for 15, 30 or 60 days. Where the pastures were long (60 days), cows grazed for 340 minutes daily. The grazing periods increased by 10% and 40% respectively on pastures rested for 30 and 15 days.

In the Winter Rainfall Region an intake study with Jersey cows on kikuyu grazing showed that despite an average dry matter intake of 2,5 kg/cow/day large amounts of grazing are wasted because not all the pastures are eaten. If sheep are permitted to graze the pastures immediately after cows, palatable, high quality regrowth is obtained.

Midmar rye grass was evaluated under irrigation at Glen in the Free State Region as a source of roughage for lactating cows. An average yield of 12,35 tons of dry matter per hectare was obtained on soil with an 82% clay content.

Cows that grazed rye grass continually were capable of producing 16 to 18 kg of milk a day with a butterfat content of 3,59% on average. Depending on the availability of irrigation water, annual rye grass can play an important part in the feeding programme for dairy cattle.

Cereals - At Dohne in the Eastern Cape Region the efficiency of milk production with whole maize, as against ground maize, in the complete ration of dairy cows was investigated. Ground maize was more advantageous than whole maize and boosted feed intake by 12%, but the physical form of the maize did not influence the efficiency of milk production. The treatment of maize with caustic soda did not affect feed intake, but did increase the efficiency of milk production by 13%.

The nutritional value of various sorghum cereals as concentrates for dairy cows was determined in the Highveld Region. It appears that bird-proof sorghum cereal cannot be recommended for use in concentrates for dairy cows. Other sorghum cereals can be successfully used, provided that problems regarding the potentially poorer utilisation of protein are corrected.

Cereal straw - It was demonstrated in the Winter Rainfall Region that ammoniated wheat straw as the only source of roughage for dairy cows and growing heifers results in poor intakes, growth and production performance. Inclusion levels of 33% of treated straw for lactating cows and 75% for growing heifers produced satisfactory results, however.

Beef cattle

Sodium bicarbonate - The possibility of producing veal economically at a calf age of 20 weeks with the inclusion of no, 2%, 4% and 6% sodium bicarbonate in the calf diets was investigated at Potchefstroom. The best results were obtained with the inclusion of 2% sodium bicarbonate. The 6% level caused bloating and is not recommended.

Veld - At Kokstand in the *Natal Region* daily live mass gains of 0,56, 0,52 and 0,66 kg/day were obtained in suckling calves on veld and stocked at rates of 0,86, 0,57 and 0,35 large stock units/ha, respectively. Corresponding calf gains per hectare were 87, 56 and 42 kg, respectively.

Winter Feeding - The composition of non-proteinic-nitrogen licks was varied and their effects on animal performance were evaluated at Dundee in an attempt to reduce supplementary feeding costs. Replacement of a portion (16%) of the salt content of the so-called Dundee lick by feedlime led to a saving of R170 for a 100-cow herd during the winter, without influencing animal performance.

The inclusion of 3% fish-meal in the Dundee lick did not improve animal mass gains in winter, but did increase the cost of the lick. Treatment of low quality veld hay with 5% molasses power and 1,5% urea by mass increased the crude protein content of the hay from 4,6 to 7,2% and the intake of dry matter from 5,2 to 6,0 kg and reduced the mass loss of mature steers from 32 to 16 kg over a 60-day period.

Sheep

Kikuyu pastures - Research with sheep on kikuyu pastures in Natal was carried out in co-operation with the University of Natal. Results showed that although the animals were only able to take in sufficient energy to supply more than their maintenance requirements for 7 out of 14 days, there was sufficient protein to supply their needs for rapid growth.

The low energy intakes are related to lower rumen filling and indicate that the animals are not prepared to eat grass of a lower quality, preferring smaller quantities of good quality grass. A shortage of high quality grazing therefore appears to be a limiting factor in this case.

Winter cereal pastures - An investigation into the possibilities of slaughter lamb production on winter cereal pastures in the Eastern Free State (Bethlehem district) has been completed. Winter cereal pastures can only be grown successfully under dryland conditions on soils that have a clay subsoil.

On soils of this kind moisture retention in summer and effective weed control are very important.

Of the various kinds of small grain studied, oats (Perdeberg or Letoria) produced the largest quantity of grazing. Oats has other advantages as well, such as adaptability on different soils, and good hay and straw qualities, and can be established from as early as the beginning of February.

A total quality of lamb that varies from 306 to 374 kg per hectare can be produced after a finishing period of about four months on winter cereal pastures. The risks attached to the production of green fodder in winter should be borne in mind, however.

Veld - At Kokstad the feasibility was examined of lambing Merino ewes on to veld during February (late summer). The trial also incorporated lambing during autumn and spring. Mortality rates in lambs of approximately 18% were recorded with late summer and spring lambing, compared with a rate of only 7% with autumn lambing. It was concluded that lambing on to veld during late summer was not feasible because of the high costs involved and the poor animal performance obtained with this practice.

Chocolate maize - In the course of an investigation with woolled sheep at Potchefstroom it was found that lactating ewes can winter very successfully on good winter veld. Strategic supplementation of up to a maximum of 500 g of chocolate maize per ewe per day is necessary, however.

Standing finger grass hay can be used for the same purpose with the same degree of success. Maize silage can also be used successfully for wintering lactating woolled sheep. However, there is a danger of toxæmia of pregnancy in highly productive ewes that receive silage during late pregnancy without the necessary supplementation.

Crop residues - The upgrading of crop residues and fibrous by-products to increase their nutritional value and usefulness for ruminants is considered an important research field at the Animal and Dairy Science Research Institute at Irene. Considerably more products such as meat, milk and wool can be produced from these feeds.

The treatment of low-grade roughage with hydrogen peroxide is a method that appears very promising at present. Techniques for applying this method in the industry are being developed at present.

Research in the Winter Rainfall Region on the urea ammoniation of roughage for sheep has been completed. Urea treatment has a greater effect on the nutritional value of wheat, oats and barley straw than on oats hay. An extension of the treatment period from 8 to 18 weeks produced a further improvement of 12% in fibre digestibility. The organic matter and crude protein digestibility of urea-ammoniated wheat straw were 7% and 35% higher respectively than in the case of stack-ammoniated and oven-ammoniated wheat straw.

Intermediary metabolism - Interactions between protein and energy supplements fed to sheep consuming low-quality forage diets were investigated at the Animal and Dairy Science Research Institute.

The type and level of supplement had a profound effect on the carcass composition of these animals and provided an explanation for differences in growth rates.

Preliminary results indicate that protein supplements will be used for fat synthesis and not muscle growth in the absence of sufficient energy supplement. The addition of small quantities of an energy supplement relieved this diversion to fat, facilitating increased protein synthesis. It is concluded that an appropriate balance of protein to energy is necessary for efficient and economical supplementation. A practical method for predicting the balance of nutrients is being investigated.

Diplodia-infected maize was investigated as a nutritional source for sheep. The inclusion of various quantities of infected maize had no effect on growth, although there were indications that feed conversion was adversely affected. It should be noted, however, that these results may hold true only for the particular consignment of maize used.

Pigs

The results of a study at the Animal and Dairy Science Research Institute showed that boars with a mass of between 30 and 90 kg took in 9% less feed, grew 7% more rapidly, showed a 17% better feed conversion and had 33% lower P2 measurements than hogs. Performance patterns showed that boars performed better than hogs even at a live mass of 30 kg.

Grain sorghum - At the Animal and Dairy Science Research Institute thermal ammonification reduced the tannin content of high tannin grain sorghum by 55,6%, whereas heat treatment *per se* had no effect. Dry matter digestibility, true lysine and methionine availability and true metabolisable energy content were significantly raised by 4,7, 25, 51,3 and 8,9% by thermal ammoniation. Heat treatment significantly reduced the true lysine and true methionine availability, namely by 9,1 and 20,8% respectively.

Ear rot maize - *Diplodia* ear rot infection of maize has increased seriously during the past production season and since the commercial value of the infected kernels as feed grain has been questioned, it was decided to evaluate such maize in pig diets. No significant differences were found between the different treatments in respect of animal health, growth, feed intake and efficiency of feed conversion. The consignment of maize used in the trial did not appear to be toxic for pigs, since no mortalities as a result of *Diplodia* infection occurred. Further research on this matter is therefore required.

Technology

Microcalorimeter - A microcalorimeter was developed at the Animal and Dairy Science Research Institute in the course of the past year; the cost is considerably lower than that of an imported instrument (R10 000 as against R150 000).

The microcalorimeter is being used in the development of a diet formulation system that manipulates the energy metabolism of rumen microbes in order to produce more efficient feed conversion.

Microbes may be said to play an important part in agriculture in South Africa in that they occur in large numbers in the digestive tracts of the 40 million or so head of stock (ruminants), where they are responsible for most of the digestive process, especially of roughage. These microbes are in turn digested by the ruminant to form the main source of vital proteins. The activity of the microbes therefore has a major effect on the efficiency of feed conversion by the ruminant.

Chrome oxide capsules - Chrome oxide capsules for use in determining grazing intake by ruminants were developed at Potchefstroom and used with very good results. Pasture intake is determined at least as accurately as with imported capsules, at a 500% lower cost than that of the imported product.

General

Trace elements - The investigation in the Winter Rainfall Region into the trace element status of animals and the demarcation of areas where trace element deficiencies occur was extended to 45 localities on the South Coast and in the Little Karoo.

A total of 3 500 blood samples, 250 pasture samples and 100 manure samples were taken for mineral analyses. With the availability of new equipment the analyses will progress more rapidly and more accurate results will be obtained.

Valley Bushveld - The dietary preferences of kudu, bushbuck and Boer goats are being studied in the Valley Bushveld of the Eastern Cape Region on a farm at Kirkwood. As many as 42 plant species which are grazed in varying quantities have already been identified. Spekboom is the primary indicator for game and sometimes constitutes as much as 72% of the dry matter in the rumen. Grasses, especially *Panicum* and *Cynodon* species, are found in fairly constant amounts (7%). During a drought spekboom is largely replaced by ghwarrie *Euclea undulata* - in amounts of up to 56%.

PHYSIOLOGY AND MEAT SCIENCE

Meat quality

Beef carcass grading - Under the South African carcass grading system for cattle the carcasses of male animals that show prominent secondary development in the forequarter are reclassified and placed in a higher age class. The justification here is that secondary male development is an indication of advanced physiological development within the chronological age groups. This could possibly be the reason why the meat from such animals is tougher and the ratio of more sought after to less sought

after cuts is less favourable than in the case of intact animals that do not show secondary sexual development.

The Animal and Dairy Science Research Institute investigated this matter. Carcasses of castrated animals in the A age group (animals without permanent incisors), intact male animals that did not show secondary male characteristics and bulls with secondary development were compared in respect of carcass composition and meat quality characteristics. Significant differences in forequarter development were found between the three groups.

Differences were found in carcass composition (bone:meat:fat ratio), which provided confirmation that the sexual development code, as applied by meat graders, provides an accurate prediction of the meat percentage in the carcass.

Non-significant differences were found, however, between the sexual condition groups in respect of meat quality characteristics and average retail prices at 60 butcheries in the Pretoria and Witwatersrand areas. On the basis of this there is no justification for reclassifying intact male animals in the A age group that show secondary male development into the B age group.

Pork - Research on the stress syndrome in pigs remains a prominent issue because of the potential financial losses that accompany the breeding of stress-sensitive pigs or halothane-positive (H+) pigs. Research at the Animal and Dairy Science Research Institute has indicated that H+ pigs have superior carcass qualities to those of stress-resistant or halothane-negative (H-) pigs, namely better dressing percentages, shorter and more compact carcasses and thinner layers of back fat. However, the advantages with regard to carcass qualities are overshadowed by the poor PSE meat (pale, soft and exudative) produced by the H+ pigs.

Mutton and goat's meat - The meat quality characteristics of the various grades of Angora goat, Boer goat and mutton carcasses were compared in an investigation at the Animal and Dairy Science Research Institute. The loin cuts were prepared by a dry heat cooking method and the cuts from the buttock by a moist heat method. The results showed clearly perceptible differences between mutton, Angora goat's meat and Boer goat's meat.

Mutton has a more intense aroma and gives a greater appearance of juiciness, is juicier and more tender, contains less residue and has a more specific species aroma than Angora goat's meat and Boer goat's meat. Angora goat's meat in turn has a more intense aroma, gives a greater appearance of juiciness and is more tender with less residue than Boer goat's meat. The quality differences between Angora goat's meat and Boer goat's meat are, however, less evident than the differences between goat's meat and mutton.

DAIRY SCIENCE

Chemistry

Several research projects and *ad hoc* studies were conducted during the year under review. Five

registered projects were completed and the results were published or are being prepared for publication.

Studies on the protein stability of milk after freezing clearly showed that milk can be successfully frozen for long periods at -20, -5 and -2°C. However, destabilisation takes place if milk is stored in a frozen condition at -15 and -10°C. Heat pretreatments for 15 seconds at temperatures between 72 and 80°C appear to have a beneficial effect.

Several usable enzymatic breakdown products of whey proteins were prepared. Although the functional food uses of unimpaired whey protein compare unfavourably with those of traditional functional food protein, they can be improved by enzymatic action.

Research on the effect of vegetable and animal fats on metabolism has been completed. The results are undergoing statistical analysis.

Inputs on pesticide levels in milk and dairy products are constantly made. Results show no reason for concern, and levels have fallen a great deal since July 1986.

Dairy technology

Ultrafiltration - New developments in the dairy industry on the use of ultrafiltration and reverse osmosis to alter milk composition and achieve better cheese yields are now being reported and work will be concentrated on achieving these results under South African conditions. It is expected that some modifications of the process will be required under local conditions.

Hydrolysis of lactose - Work has been completed and published on the hydrolysis of lactose into glucose and galactose to improve the sweetening strength and reduce costs of production in ice cream and yoghurt. Other possible uses are still to be investigated. Because of lactose intolerance in a large proportion of the South African population this process could increase the use of dairy products in the lactose intolerant groups of our population.

Spray-drying - The work on the manufacture of casein and caseinates with existing cheese and spray-drying facilities has now been completed and published. It has been used successfully under commercial conditions and with the world prices of these products increasing rapidly a considerable amount of overseas currency could be saved with local production.

Demineralisation of whey - Experimental work on the ammonium bicarbonate method of demineralising cheese whey has reached the stage where extension can be given to the industry in the application of the method. Research will in future be concentrated on finding new ways of utilising demineralised whey, and on the use of the ammonium bicarbonate method of utilising other dairy products.

Dairy microbiology

Research on the microbiology of milk and dairy products centres around the growth and survival of microorganisms in raw milk and dairy products that have been stored after manufacture. Research is being undertaken with the object of enabling the dairy industry to ensure that the consumer receives a safe, high quality product.

A more sensitive method of tracing gas-forming sporeformers in cheese on a routine basis has been developed. This is a useful method, especially for manufacturers of processed cheese.

A survey study which was carried out at cheese factories on the use and handling of starters revealed unmistakable problems with regard to dairy technology in South Africa. This survey is the basis of a comprehensive research programme on the rapid and accurate characterisation of starter strains in order to enable the industry to select strains that possess characteristics of outstanding practical value.

Intensive investigations into the incidence of psychotrophic Enterobacteriaceae in dairy products were also launched during the year under review. Although this group of organisms has already been thoroughly studied, the effect they have and their practical importance at low storage temperatures are as yet unknown. Traditionally it has been accepted that this group of organisms cannot grow at temperatures lower than 7°C.

Pilot trials on the formation of biofilms in milk pipeline systems and their influence on the shelf life of pasteurised milk were carried out.

Development

During the past year attention was given mainly to the milk produced by primary milk producers and the milk (pasteurised or raw) distributed by producer distributors and small distributors experiencing problems with the quality of their product.

Attention was also given to the chemical and bacteriological quality of a variety of dairy products. The quality of the products was very high on the whole and a few creameries frequently gained full marks for chemical and bacteriological analyses.

Mastitis control

A comprehensive investigation into several aspects of mastitis in the Winter Rainfall Region has been completed. Guidelines based on the results of this investigation have been laid down for a mastitis control programme which is being vigorously applied in the Region at present. Healthy animals, clean, dry sleeping quarters and pens, hygienic milking parlours and equipment and hygienic milking conditions clearly reflect low somatic cell counts, with accompanying economic advantages.



Blood identifications are used to determine which *Culicoides* midges are potential virus carriers

Young Nguni bulls on the Loskop South Experimental farm of the Animal and Dairy Science Research Institute. Much interest is being shown in this highly fertile indigenous cattle breed



Cell cultures in flasks for the production of various virus vaccines at Onderstepoort



A group of sheep eating activated charcoal pellets as prophylaxis against *Senecio* poisoning



Rumen studies being done with sheep on cultivated pastures

**Jersey cows on kikuyu pastures at
Elsenburg**



**Different methods for preserving
meat are investigated at the Meat
Science Centre of the Animal and
Dairy Science Research Institute at
Irene**



**Inoculation of eggs for the production of equine influenza vaccine at
Onderstepoort**

**Members of Parliament visiting the bull pens used in the Beef Cattle Performance
Testing Scheme at the Animal and Dairy Science Research Institute at Irene**



Milking - Elsenburg

The functions of the Animal and Dairy Science Research Institute at Elsenburg are geared chiefly to the needs of the dairy industry of the Western and South-Western Cape. Certain duties extend to the whole country, however.

Extension on the subject of dairy science is supplied to both the primary and the secondary dairy industry. An analytical service is rendered in respect of both the bacteriological quality and the chemical composition of milk and dairy products. Milk samples, specially constituted and analysed according to reference methods, are routinely supplied to milk analysis laboratories throughout the country as calibration material for checking their infra-red milk analysers.

Somatic cell counts that serve as a criterion for the incidence of mastitis are also supplied on a monthly basis to about 2 000 primary producers in the Western and South-Western Cape.

Dairy training - Glen

Seven courses on various aspects of the dairy industry, including an introductory course on dairying, were presented during the year under review and attended by a total of 49 students.

POULTRY SCIENCE

Breeding research

The introduction of two genetic control flocks for meat breed chickens at the Animal and Dairy Science Research Institute was the realisation of an ideal that had long been cherished. An analysis of results of the laying hen genetic control flock indicated that the flock has remained genetically constant over a period of twelve years.

Large quantities of hatching eggs were supplied to the Veterinary Research Institute at Onderstepoort for the preparation of equine influenza vaccine and to the Institute for Virology for the preparation of human vaccines.

Nutrition

A very strong research team came together at the Animal and Dairy Science Research Institute to carry out efficient poultry nutrition research. Various applied research projects were performed, mostly on the evaluation of feed components.

Studies on sorghum showed that it can replace maize in a milled or unmilled form very efficiently. The only problem was that the colour of the broiler skin and egg yolks were lighter, but this could be rectified. Wheat and unrefined brown sugar were also used to replace maize efficiently in laying diets. The same effect on egg yolk colour was noted as with the sorghum diets. The feed intake increased as the inclusion of sugar went up to 400 g/kg.

Various rapid biological methods to identify fish-meal samples that will cause gizzard erosion were studied. No decisive method could be established, but a seven-day test period and 70:30 fish-meal:maize diet identified the problem efficiently.

A study on full-fat soya was started using an industrial microwave oven. Results to date are promising and the most efficient product will be compared with commercial full-fat soya.

Poultry meat

Studies have been conducted to investigate the physiology of growth of broilers for meat production. The physical and chemical components of the bird were analysed at each stage of the growth process until maturity. Mathematical models were derived to describe the changes that occur in the bird during growth.

Waterfowl

Nutrition - Restricting the feeding of ducks at an earlier age (3 weeks) as opposed to 8 weeks was continued. Results showed that restricting at an earlier age was both beneficial and more economical.

Reproduction - Very good progress is still being achieved by the Hagedoorn system of selection on Pekin ducks. The fertility, hatchability and average body mass have all improved. The most notable achievement was the average body mass of 3 383 g at seven weeks which compares favourably with the best in the world.

PERFORMANCE AND PROGENY TESTING

Beef cattle

The meat industry is in a more favourable position after the drought has ended in large parts of the country and meat prices have reached high levels. This has given the Beef Cattle Performance and Progeny Testing Schemes added momentum so that membership has increased and the demand for growth tests on young bull calves in particular has been stimulated.

The membership of the scheme has increased by 25, to 1 842, which represents 2 092 herds. A total of 7 950 bull calves have been subjected to growth tests, which is 497 more than in the previous year and indeed constitutes a fine achievement.

At present the meat industry requires about 33 000 bulls a year. This means that 24% of the bulls are subjected to performance testing in controlled growth tests. A large number of bulls are also subjected to the uncontrolled phases of the scheme.

Dairy cattle

At present 1 783 herds and 105 567 cows on average are tested monthly in terms of the dairy cattle

performance testing scheme. This indicates increases of 83,2% and 115,2% for herds and cows, respectively, over the past ten years.

Average milk production has increased by 17% over this period, from 4 040 to 4 727 kg. With the inclusion of check tests, 1,46 million tests were carried out to determine milk mass and butterfat, protein and lactose values. The number of young bulls nominated for the progeny testing programme amounted to 302, 173 of which were found acceptable and 52 of which were purchased by the AI industry.

About 23 334 first lactation records were screened for bull evaluation. In all 1 524 bulls were analysed. The results of only 524 bulls qualified for publication.

Woolled sheep

During the year under review a record number of 53 956 wool samples were analysed in terms of the National Woolled Sheep Performance and Progeny Testing Scheme. The sale of performance-tested Merino rams by veld ram clubs has become increasingly popular, and 19 selected rams participated in the progeny testing scheme. The seven rams with the highest breeding scores for general excellence were approved for the sale of semen as State-nominated rams. The scheme is beginning to play a considerable part in the genetic improvement of woolled sheep.

A linear scale for awarding marks for subjective qualities in Merino sheep was developed by officers of the Karoo Region and the National Woolled Sheep Performance and Progeny Testing Scheme. Conformation and wool qualities are broken down into single qualities and marked on a scale of 1 - 100. This linear scale of marks is already being applied in the national progeny testing programme of the Merino Stud Breeders' Association. The linear scale of marks is also used to estimate the genetic and phenotypic parameters of non-measurable wool and conformation qualities.

Mutton sheep and goats

There has been increasing interest in the Mutton Sheep and Goats Performance Testing Scheme. Breeders are also showing increasing interest in hardy indigenous breeds such as Damara sheep and Sanga goats.

Farmers are becoming ever more aware of the fact that veld grazing is a scarce resource that has to be utilised to the optimum. This has done a great deal to boost interest in ram evaluation, especially in phases D1 and D2, in which the efficiency of feed conversion is estimated.

During the year under review a record number of 3 860 rams participated in phases D1 and D2 tests.

Pigs

During the year under review 2 398 boars were admitted for testing, 2 050 boars completed the test and 1 422 boars (59%) qualified.

Although the improvement in feed conversion was small, a positive trend was nevertheless evident. The average feed conversion for all centres and all breeds decreased from 2,34 to 2,32.

Following the application of stricter standards, there was a significant reduction in the percentage of superior boars, i.e. from 7% to 1%.

The halothane test for stress sensitivity was reintroduced for all breeds.

Poultry

The 17th random sample egg laying test and the 14th broiler test witnessed new achievements this year. In the broiler test an average body mass of 1 999 g was achieved at the age of 45 days. Eight years ago the same mass was attained at the age of 56 days. Housing is therefore being more efficiently used, since the slaughter age has been considerably reduced and more groups can utilise the houses in the space of a year.

In the egg laying test the highest ever egg production per hen day in a test at Irene was achieved by hens belonging to an entry from the USA, namely 294,4 eggs. The entry was initiated by a local breeder. The two highest egg production figures for local entries were 277,5 and 273,2 eggs per hen day.

VETERINARY RESEARCH

The research activities of the Veterinary Research Institute at Onderstepoort can be gauged by the 87 scientific publications produced by its researchers and published during the year under review. Vaccine sales rose to 164 million doses, while 330 000 samples were received for analysis. Of these 1 300 came from abroad. Highlights as regards research results were the following:

Pathology and electron microscopy

During the past year 2 589 cases were dealt with, of which 1 395 were tissue samples in formalin for histopathological analysis. Post-mortem investigations were performed in 807 cases, of which only 92 can be regarded as non-economically important animals. In the majority of these cases owners initiated legal investigations because of suspected malicious poisoning.

Serious problems were experienced in feedlots where excessive amounts of poultry dung were fed to cattle over long periods. Most affected animals died without displaying any clinical symptoms, though a

few did show signs of congestive heart failure. The toxic fraction in the dung has not yet been identified, but there are indications that ionophores, added to chicken feed as coccidiostatic substances, may play a role.

A high percentage of maize was infected with the fungus *Diplodia maydis* during the past season. Although the effects of this fungus on mature animals are known, there is very little information on its effects on the foetus. On two farms where maize was heavily infected with *D. maydis* there were many stillborn lambs and what are referred to as lame lambs. Although the possible role of *D. maydis* has yet to be confirmed, circumstantial evidence suggests that this fungus might well play a role.

There are strong indications that high manganese levels in soil, and the resultant manganese poisoning, are the cause of liver lesions in calves with the so-called Vryburg hepatitis syndrome that occurs on certain farms in the Vryburg area. The condition is of economic importance since large losses are sustained through high calf mortality.

Gousiekte remains one of the most important plant poisonings in the country. It has not been possible to isolate the toxic fraction to date, but there are indications that it will soon be possible to identify the active ingredient in the plants concerned. Much attention is at present being focused on the pathogenesis of the lesions in the heart. The possible role of acquired auto-immunity is being investigated.

The life cycle of *Cowdria ruminantium* has not yet been studied in full and the role in heartwater of the two morphological forms, namely the electron-dense and the reticular forms in heartwater, are being investigated at present.

Research on poisonous plants

The research on cardiotoxic glycosides was completed. In the process two known bufadienolides were isolated and identified, and 16 new bufadienolides were isolated and their chemical structures determined. The bufadienolides investigated provided evidence that only those with a sugar group in the L-form give rise to a cumulative effect and could cause krimp siekte. This research resulted in 10 publications.

Contrary to what is generally believed, *Ornithoglossum viride* contains no cardiotoxic poison glycoside. Further investigations are being conducted into the toxicity of this plant.

The problems encountered with the purification to the toxins from *Ornithogalum thyrsoide*s and *O. prasinum* were solved by derivation. A toxic extract of *Athanasia trifurcata* is being investigated for the presence of furano-sesquiterpene essential oils.

Bacterial diseases

Actinobacillus pleuropneumoniae, which causes necrotic pleuropneumonia in pigs, caused a severe outbreak in May 1987 in an Orange Free State

piggery. Heavy losses occurred on this farm. The disease has spread rapidly during the year under review and it is now known that 14 farms in all four provinces are involved.

Corynebacterium (Actinomyces) pyogenes is causing concern as it is on the increase in both the cattle and the sheep populations. It usually manifests as chronic abscess formation and causes widespread economic losses.

In the work done on mycobacteria 95% of acid-fast isolates from bovine tissues were *M. bovis*, whereas 72% of the acid-fast isolates from pig specimens were *M. avium intracellulare* and 22% were *M. tuberculosis*. All mycobacteria isolated from a group of black wildebeest were clinically non-significant.

Mycoplasmas have once again been isolated from a wide spectrum of farm animals, chickens and pigeons. Bovine genital mycoplasmosis is still widespread, but its pathogenic potential is somewhat controversial.

Progress has been made in the isolation and cloning of the *Mycoplasma* regarded as the main aetiological agent of balanoposthitis in Dorper sheep.

In the poultry industry *Mycoplasma* infections comprised 19% of all specimens received and mycoplasmosis remains one of the more important erosion diseases of this industry. Monitoring *Mycoplasma* infections remains an important method to determine its occurrence in the meat and egg industries.

Reproductive diseases

Brucellosis is still the most important cause of abortion in cattle (8,4% of all abortions). Leptospirosis has been found as a cause of abortions in cattle and pigs. The extent of the problem has not been defined and further epidemiological work on this disease is necessary. The antibiotics added to frozen semen are effective in preventing the growth of *Leptospira* organisms *in vitro*.

Trichomoniasis is found in 9,5% of field specimens submitted and is an important wasting disease of cattle affecting fertility. The search for a vaccine has high priority as other control measures are difficult and expensive. Campylobacteriosis, on the other hand, is found in 5% of field specimens and the vaccine is efficacious.

The absence of the *Brucella melitensis* Rev. 1 mutant designated FSA from field isolates since 1986 seems to indicate that this strain is not capable of establishing itself in the field.

The laboratory was successful in producing *Brucella* phages.

The serological testing of cattle for *Brucella abortus* has averaged over 30 000 sera per month and this is the maximum that the laboratory can handle. There has been a dramatic drop in the prevalence of positive reactors from 4,6% in 1982/83 to 1,6% in 1987/88. This indicates progress at least in establishing a number of herds that have been cleared of the infection.

Protozoal diseases

Diagnostics

The Veterinary Research Institute was involved in the confirmation of two separate diagnoses of *Leishmania*, one in a dog from the Cape Province and the other in a sheep from the Transvaal. It was the first time this parasite has been recorded in the RSA.

Vaccine production

The first attempts at making frozen redwater and anaplasmosis vaccines, to be kept in dry ice or in liquid nitrogen, were successful. The advantage of a frozen vaccine is that it would be readily available at any time throughout the year. Full scale production will depend on consumer demand.

Babesiosis (Redwater)

Cattle - Various suspected tick species have been tested in the laboratory as possible vectors of a fourth (up to now unidentified) *Babesia* sp., of which the vector is still unknown. It is apparently of no economic importance, but it does complicate the interpretation of serological results from cattle in epidemiological studies. It crossreacts not only with the two economically important species but also with *B. occultans*, which is transmitted by *Hyalomma marginatum rufipes* and has a very wide distribution. Alternative diagnostic techniques are thus necessary in order to distinguish between mixed babesial infections.

Attempts to prevent severe redwater vaccine reactions in adult animals with a 1/3 dose of Berenil, and to study the implications of this treatment, are still under way. There is a need for block treatment of high-risk animals on farms where extensive farming is practised under circumstances where it is not possible to monitor vaccinated animals individually on a daily basis for vaccine reactions.

Horses - Our suspicion that *Hyalomma truncatum* is a vector of *Babesia caballi* has been confirmed for the first time in the RSA.

Besnoitiosis (Elephant skin disease)

Renewed attempts at identifying the final host of *Besnoitia besnoiti* have thus far yielded no positive results. Lions, leopards, cheetahs, jackals, mongooses, domestic cats, vultures and hyenas have been tested, but none of the developmental stages of the parasite have been found in the alimentary canals of these carnivores.

Theileriosis (Corridor disease)

Serum samples of 3/25 cattle from Mbedlana, Zululand (outside the Corridor endemic area), where

no buffaloes are present, gave positive serological reactions with *Theileria parva*-group antigens. Refined serological tests or alternative methods will have to be developed to investigate this phenomenon thoroughly. These serological results indicate that there may be *T. p. lawrencei* carrier cattle in this area. The implications are that Corridor disease outbreaks may occur that may lead to possible behavioural transformation of this parasite, which could result in outbreaks of the typical East Coast fever syndrome.

T. p. lawrencei isolations can now be made with ticks collected from buffaloes in the Kruger National Park for laboratory investigations at Onderstepoort.

Anaplasmosis (Gall sickness)

The infectivity of the freeze-dried *A. centrale* experimental vaccine, which has already been tested on four farms in the Gobabis district in South West Africa, seems to be satisfactory. If this vaccine proves to be economically viable it may be recommended for large scale production in the near future. At present it is distributed on dry ice and can be stored in a domestic deep freeze at approximately -20 °C for at least 12 months.

Calves that contract transplacental *Anaplasma* infections and subsequently remain subclinical carriers should have adequate immunity against natural infections when their non-specific immunity wanes after the age of about nine months.

Promising results were obtained with the freeze-drying of *Aegyptianella pullorum*. This parasite can serve as a model for further studies on the freeze-drying of *Anaplasma* spp. Chickens for use as experimental animals are more readily available and far cheaper than cattle.

Heartwater

Progress was made with more effective immunization. In a series of field experiments the preliminary results showed that sheep and goats can be immunized satisfactorily by simultaneously administering the vaccine intravenously and implanting slow-release antibiotics subcutaneously. Controlled tests under laboratory conditions will, however, still be necessary before this method can be implemented. It also was found that a significant percentage of sheep were immune to challenge after immunization with heartwater-infected tick nymph suspension to which hyaluronidase had been added and then administered intramuscularly. Here, too, confirmation from laboratory trials is necessary.

The successful freeze-drying of heartwater vaccine is now in sight. The infectivity of heartwater-infected sheep blood that had been freeze-dried and then stored in a deep freeze did not diminish for several months. A few practical implications still have to be followed up.

The apparent lack of cross-protection between the different heartwater strains was demonstrated

more clearly using larger numbers of animals. The fact that sheep vaccinated with the Welgevonden strain are immune to a wider spectrum of strains than is the case with any other strain, especially the Ball 3 strain, raises the question whether the latter is still the appropriate strain for the vaccine.

As regards the pathogenesis and epidemiology of the disease, progress was slow. The high natural resistance of young calves from susceptible mothers was confirmed; previous observations on this effect were based primarily on circumstantial evidence. There is now conclusive evidence that at the time of infection of such calves the complement levels do not play a role in their resistance. The finding that *Cowdria* organisms occur in significant numbers in the blood of these artificially-infected calves, which display few or no clinical signs, indicates that the mere presence of the organism is neither the essential nor the only factor in the pathogenesis. Other factors, probably the cellular and humoral constitution of the host itself, also play a role.

After studying a closed herd of cattle in a heartwater-endemic area, the conclusion was reached that small numbers of ticks apparently maintained the herd immunity. Although various factors and observations militate against such an assumption, these observations reveal anew the complex nature of the epidemiology of this disease.

The discovery that rifampicin is suitable for the treatment of heartwater, and that it can be formulated for topical administration, generated much interest. The technology was patented and, with the assistance of the SA Inventions Development Corporation (SAIDCOR), sold to a pharmaceutical company, which will undertake its registration and further development and marketing.

Molecular biology

Over the past four years the research activities in the field of rickettsia-like and protozoan parasites have increased. The organisms worked on include *Anaplasma* spp., *Babesia equi*, *B. caballi* and *Cowdria ruminantium*. In addition research is continued on the jaagsiekte retrovirus (JSRV). All these organisms are the causative agents of economically important animal diseases in South Africa.

A number of DNA probes have been isolated from the genomic libraries constructed for *Anaplasma* and the two species of *Babesia*. The *Anaplasma* probes, of which there are four, show specificity for *Anaplasma centrale* (1) and for both *A. centrale* and *A. marginale* (3). These probes have been mapped and are at present being sequenced. Restriction mapping has revealed differences between the four probes and the regions responsible for the specificity have been identified. These probes can detect 8 ng of *Anaplasma* DNA and work is also in progress to try to increase their sensitivity.

B. equi and *B. caballi* libraries have been constructed in both lambda *g*11 and pUC expression vectors. DNA probes have been isolated for both species of this parasite. It is thought that

these probes contain repetitive DNA sequences, making them very suitable for development into a diagnostic test for equine babesiosis. Restriction maps of the *B. equi* probes have been constructed and we are now identifying the repetitive sequences.

A breakthrough has been made in the isolation of *Cowdria ruminantium* DNA from a tissue culture cell line.

A novel retrovirus termed the bovine retrovirus (BRV) has been identified. This virus shows serological similarities to the JSRV. Since it is relatively easy to obtain sufficient quantities of the BRV, it is intended to clone its genetic material and to use it as probe to identify the JSRV. This is based on the assumption that since there are serological similarities there should be genomic similarities.

It is hoped that we will shortly be able to evaluate a rapid diagnostic test for anaplasmosis based on DNA probes. The isolation of the JSRV genome should make the development of a similar test based on probes possible and eventually lead to a sub-unit vaccine against jaagsiekte.

Viral diseases

Diagnostics

During this past year 7377 serological tests were performed on the sera of cattle (2204), sheep (1706), goats (467), horses (2664) and others (336). By far the biggest request was for equine influenza testing - 2330, followed by 591 for bovine viral diarrhoea.

Equine viral arteritis antibodies were found during a routine epidemiological survey and the virus was isolated in the Republic for the first time.

Contrary to expectation, no cases of Rift Valley fever were seen.

During the year 1816 specimens were examined for rabies: of these 687 were positive. The incidence of rabies in Natal was still high in dogs and there was an increase in cases of bovine rabies, particularly in the Soutpansberg District.

Horse sickness occurred in a particularly peracute form and types 2 and 4 dominated. With bluetongue, which showed an increase over last season, it was serotype 12 that prevailed. The electron microscope was again extensively used for diagnostic work.

Biochemistry

Eight new facets and one pilot facet were begun during the year under review. Molecular and immunological aspects of members of the orbivirus genera, to wit bluetongue virus (BTV), horse sickness virus (HSV), equine encephalitis virus (EEV) and epizootic hemorrhagic disease virus (EHDV), are being investigated. Good progress has been made on bluetongue virus in previous years and the present facets are all a continuation of these endeavours. Work on the other viruses is still in its initial stages.

A pilot facet was initiated to investigate the cell-mediated immune response against BTV. The

lymphocyte transformation technique is at present being standardized. Once it is working well the part played by the various BTV proteins in the cellular immune response can be studied.

Foot and mouth disease

The primary objectives for which the FMD Laboratory was established, viz. FMD diagnosis and vaccine production, are being achieved satisfactorily.

Although no suspected FMD outbreak specimens were submitted for diagnosis during the year there was a heavy demand for serological evaluation, particularly for the translocation of game species either from Zimbabwe to South Africa or from the Eastern Transvaal Lowveld to other parts of South Africa.

Production of bivalent (SAT-1 and 2) vaccine now more than fulfils South Africa's requirements and the potencies of both valencies are excellent. There is still a problem with SAT-3, for which we have not yet been able to identify a strain that is a good immunogen producer and that is also stable when subjected to the production process. Interestingly, strains we have tested that are in use with other producers are unsatisfactory in our hands. Nevertheless, we are confident of overcoming the problem by the end of 1988.

Collaborative projects aimed at improving the duration of vaccinal immunity and possibly production capacity are an exciting prospect and should help us to compete successfully internationally and market our vaccines over a wider area than at present.

The implementation of ELISA techniques for serology is beginning to pay dividends since we are now able to handle many more sera than was previously the case.

The start made on the application of newer biotechnological techniques to the epidemiological and vaccine situations peculiar to this part of the world presents potential solutions which could be of great practical benefit.

Good progress has been made towards understanding the epidemiology of the SAT virus types with respect to cattle and wildlife. We now have accurate data on the virus excretion patterns of cattle, pigs, buffalo and impala and on minimal infectious dose levels by the respiratory route for cattle and impala. We have, furthermore, been able to postulate mechanisms by which the SAT-types are maintained by buffalo populations and occasionally escape from them into cattle.

On a more applied level, we are now in a position to provide recommendations on the movement of animal products such as trophies and biltong from FMD enzootic areas.

External parasites

Culicoides/Arboviruses

A taxonomic survey of the *Culicoides* midges of the national parks has been extended from the Kruger

National Park to include the Tsitsikamma Coastal and Augrabies Parks. The Tsitsikamma area is unique entomologically and three or four new species have so far been discovered there. Previous work in the Kruger Park led to the discovery of four *Culicoides* species breeding in elephant dung.

Many of the 40 species of *Culicoides* collected recently in Malawi do not occur in the Republic, but provide an important link between the *Culicoides* species of South Africa and those occurring further north in the Afrotropical Region.

A start has been made on a study of the taxonomy of the pupal stage of Transvaal *Culicoides*.

During the past year a light trap survey of the *Culicoides* species associated with stock in Natal has been conducted in collaboration with all the State veterinarians. From 57 farms 497 collections were made and must now be identified. An intensive two week study of the *Culicoides* on farms within a 30-km radius of Onderstepoort was also completed. *C. imicola* was the dominant species at 30 of the 31 sites where light traps were set. A third study was the one-year survey in a bovine malignant catarrh outbreak area near Thabazimbi. *Culicoides* were collected on a cattle ranch and on the neighbouring game farm. The collections contained an unexpectedly high number of species (31), 10 of which breed in tree holes.

A two year study to determine the value of an ELISA test to detect African horse sickness antibodies in donkeys has been successfully concluded. This ELISA test can now be used to determine the actual distribution of AHS throughout the donkey population of the RSA and thereby, it is hoped, contribute to an understanding of the epidemiology of AHS.

Simulium

The control of blackflies is a very real problem, especially along the Orange River. Water level fluctuation can be practised only during very limited periods that will not drastically upset the crop farmers. However, Eskom's hydroelectric generation requirements also have to be considered. This means that it becomes almost impossible to implement water fluctuation at the correct time for a long enough period.

Since September 1987 blackflies have been an extremely serious problem. The floods in February 1988 were expected to upset the life-cycle of the nuisance species severely, but two to three weeks later they were back in pest proportions. Water fluctuations and floods appear to have a greater effect on the natural enemies of this midge than on the midge itself. This blackfly is a true pioneer species designed to utilise conditions unsuitable for other species or predators. For this reason the use of an effective larvicide such as temephos, which has been used successfully in West Africa should be seriously considered.

The role of insects in bovine malignant catarrh transmission

A recent outbreak of malignant catarrh in cattle adjacent to game farms in the Sentrum area of the North-Western Transvaal led to a one year study of likely mechanical vectors. Eleven species of *Musca* flies were found on cattle. Many of these were also reared from cow dung, but only two species were common in wildebeest dung. As winter is the main period of malignant catarrh transmission, special attention was paid to the flies which were still common then. If malignant catarrh is transmitted from the eyes of wildebeest to the eyes of cattle the best fly candidates in this area would be *M. xanthomelas*, *M. lusoria* and *M. fasciata*.

Epidemiology of Karoo paralysis

Laboratory breeding under cold conditions has produced higher yields of ticks within shorter periods. Laboratory-bred nymphae have elicited paralysis of rabbit hosts under cold conditions: the first laboratory inducement of Karoo paralysis.

Field data have confirmed that the majority of matings take place before host contact; confirmed the preference of immatures for southern slopes; shown the major immature hosts to be elephant shrews, red rock rabbits and caracals, and revealed host paralysis to be associated with the engorgement phase and tick burden.

Tick immunogens

Infestation of previously immunized cattle with *Rhipicephalus appendiculatus* indicates that the immunity elicited by gut antigen is still active after six months. Rabbits were found to be good indicators of specific immunity with *R. appendiculatus* and useable with *Amblyomma hebraeum* where breeding of adults is a problem.

Internal parasites

Epidemiology of conical fluke infection

Several field outbreaks of this parasite were investigated in cattle. The drugs oxyclozanide and closantel yielded good results and can therefore be recommended in the event of infestation in cattle. It should be noted, however, that the dose of closantel is four to eight times higher than the registered therapeutic doses prescribed for the treatment of wireworm, hookworm, and liver fluke infection.

It was confirmed that, although most of the outbreaks occur late in summer, they can take place at any time of the year. In one case it was clear that sufficient infested intermediary hosts survived the winter to give rise to an outbreak at the beginning of spring.

Although formerly only 1% of metacercaria (the infective "larvae" of the conical fluke) survived

12 hours of desiccation in the laboratory, it has now been found that similar metacercaria, which had been exposed to drying out, sun and wind in the field for at least three days, were just as infective as fresh material that had been kept moist continually.

Resistance of worms to vermifuges

Last year it was pointed out that with the exception of the levamisole/morantel group, worms, under local conditions, had become resistant to all the vermifuges widely in use in South Africa. In the past year, however, two cases of resistance were reported against these remedies too, namely a wireworm and bankrupt worm strain in Natal. In the case of the bankruptworm both levamisole and morantel were completely ineffective, since the treated group of animals were host to more worms than the untreated control animals.

A worrying phenomenon that has come to the fore is the spread of worm strains through the selling of affected animals to other farmers.

A trial was conducted in co-operation with private concerns to test whether a benzimidazole-resistant strain of wireworm could be replaced on the pasture with a susceptible strain of the same species.

The results were promising; there was apparently a reversal in the resistance of the strain on the pasture in three of the five test camps.

Much more work has still to be done to confirm these results, and there are also questions regarding the acceptability of the principle that the farmer has to infect his animals with a susceptible worm strain in order to apply this method. However, resistance is becoming so important that anything promising will have to be followed up fully. In South Africa there may soon be no vermifuges with which to control parasitic worms. If this happens the farmers will have no choice but to resort to other methods of control, even if they are unpopular.

Toxicology

The quality of the diagnostic service has been much enhanced by the acquisition of a gas chromatograph mass spectrometer. Insecticides, especially the organophosphorus compounds, were responsible for a large percentage of poisonings. In one incident alone, over 300 cattle died after being exposed to parathion from cans wrongly labelled as acaricide. The balance of the poisonings were caused by arsenic, prussic acid, nitrates, sodium fluorosilicate, sulphur, ionophore antibiotics, copper, phosphene and salt.

A chemical pathological study of gousiekte revealed that myocardial damage and reduced cardiac function occurred in the latter half of latency, often after dosing had ceased. Elevation of the levels of aspartate transaminase (AST) and lactate dehydrogenase (LD) in the serum proved to be useful indicators of cardiac involvement in gousiekte. So sensitive was AST that elevations of

this enzyme could be used to identify affected sheep in a natural outbreak of the disease. In addition to the clinical pathological work, an in-depth investigation of the pathogenesis of gousekte is being carried out from the novel point of view that it is an immunopathological condition.

Food and milk hygiene

A large turnover in staff during the past year limited research in this field to certain aspects of mastitis and udder health control. A two-day workshop on the standardisation of somatic cell count (SSC) determinations in the RSA was organised in collaboration with the Faculty of Veterinary Science at Onderstepoort. The meeting was well supported by the various South African laboratories participating in the scheme and subsequent inter-laboratory trials indicate a marked improvement in the standard of SSC determinations. Communication between the laboratories and the Institute has also improved significantly and the general interest in large-scale SSC determinations for regular screening of herd udder health has escalated, particularly at the laboratories of private bodies and the Dairy Board.

Research on aspects of the pathogenesis of mastitis, including investigations of fluctuating levels of reducing sugars in milk, has provided particularly interesting original data on the phenomenon of mammary regression. The data show for the first time that regression of secretory mammary epithelium is a phenomenon which starts with a recognition response, is followed by an alarm reaction, and terminates with the manifestation of regression proper.

Results of contract research on aspects of rancidity of milk have shown that lipolysis is a common phenomenon in most milks and mastitic milks tend to have significantly elevated levels of lipolysis.

The study emphasises the importance of sound udders in the production of organoleptically acceptable and dairy-technologically useful fresh milk. Unless udders are healthy and secrete normal milk, elevated levels of lipolysis and increased problems with consignments of rancid milk will occur irrespective of the efficient chilling of milk on the farm and during transportation. Because such rancidity defects are aggravated by chilling and cannot be eliminated by pasteurisation, the results clearly emphasise the urgent need for improved udder health of South African dairy herds.

Poultry diseases

Diagnostics

During the year under review 8867 post mortem examinations and 29222 serological tests were performed, an average of 35 post mortems and 120 serological tests per working day. This took place in the virtual absence of any serious disease outbreaks,

the two most important diseases being again pulmonary hypertension syndrome/ascites and *E. coli* septicaemia in broilers. There was also a general increase in broiler mortality to close to 15%, compared with 3% obtained in a recent country-wide survey in New Zealand.

The increase in turnover of specimens seems to reflect a growth in demand for a diagnostic service caused by the combined effect of the continuing growth of the industry and the increasing broiler mortality problem.

A survey of antimicrobial resistance of *E. coli* to commonly used remedies in the poultry industry was initiated. Although the sample size is still too small to draw final conclusions, the results of the initial 38 isolates collected and tested indicate that resistance, in particular to the sulphas and oxytetracyclines, is a cause for concern. This emphasises the necessity that the use of these products must be controlled by either the pharmaceutical industry, the registration authorities or the poultry industry in order to conserve the efficacy of the remedies.

Broiler ascites

Angiography of lung arterioles of broilers showed degrees of vaso-constriction proportional to degrees of right ventricular (RV) hypertrophy. In addition to the packed cell volume, the total blood volume was also found to increase in proportion with the degree of right ventricular hypertrophy. Continuing tests of different broiler lines at the Animal and Dairy Science Research Institute, Irene, showed differences in the reactivity of the right ventricle which are not related to susceptibility to hypoxic conditions.

An explanation for the high incidence of ascites in winter was found by the demonstration of an increased oxygen demand with cold. In a morphological study of RV hypertrophy it was found that the RV wall stretches to allow for a larger RV volume and increases in thickness, but the surface area of the heart occupied by the right ventricle also increases in proportion to the degree of hypertrophy. This phenomenon has not been recorded in other species.

Turkey malaria

In host-range studies the Japanese quail (*Coturnix coturnix*) was found to be susceptible to infection with *Plasmodium durae* but the helmeted guinea-fowl (*Numida meleagris*) and domestic ducklings (*Anas platyrhynchos*) were found to be refractory. While it was possible to infect embryonated eggs of both turkeys and fowls, the parasites multiplied more rapidly in chicken eggs. Chickens, however, are also refractory.

Pathological studies on turkeys, which died from *P. durae* infection or were slaughtered after recovering, showed increased relative right ventricular mass in comparison with non-infected controls.

In an attempt to quantify splenomegaly the spleen-heart ratio was investigated and found to be a more reliable indicator than the relation of spleen mass to body mass.

A plasmodium was isolated from live guinea fowl from Pienaars River by blood transmission in turkeys and chickens. Morphologically this parasite does not seem to fit any existing description. While being able to multiply in chicks, it shows a very high degree of pathogenicity to turkeys.

Fish diseases

The most important diagnoses made during the year under review included streptococcosis of rainbow trout, the isolation of *Pseudomonas* from diseased tilapia from South West Africa and the isolation of *Edwardsiella tarda* (the first in South Africa) from tilapia. These are the first isolations of pathogenic bacteria from tilapia in South Africa. Two diseases of catfish were also investigated. The first involved *Epistylis* infestation of the gills of fry and the other was a new syndrome which was called idiopathic intestinal bloat syndrome. The fact that infectious pancreatic necrosis virus has not been isolated during this period is also noteworthy.

A selective isolation procedure, capable of detecting two bacteria per ml, was developed for the *Streptococcus* species responsible for trout streptococcosis. This selective process will facilitate the epidemiological work on trout streptococcosis. The South African isolates of pathogenic fish *Streptococcus* are biologically and serologically distinct from the Australian trout *Streptococcus* and the Israeli tilapia *Streptococcus*. From MIC determinations it was found that Erythromycin and Baytril were the most effective against our *Streptococcus* isolate.

VACCINE DEVELOPMENT

The objectives with vaccine development are primarily to improve existing vaccines, to develop new ones where necessary and to provide scientific support for routine vaccine production. Diagnostic reagents are produced and standardised. In view of the availability of specific expertise certain diagnostic functions are also performed.

Vaccines that are receiving attention with regard to improving production methods are *Bacillus anthracis* spore suspension vaccine and *Clostridium botulinum* toxoid. Improving the methods of production will allow large volumes to be produced with greater ease and with less possibility of contamination.

Problems arising from vaccination with bacterins necessitate their replacement with live attenuated vaccines.

The purification of toxins such as that used for *C. tetani* vaccine production will yield a more immunogenic product that will have a reduced tendency to cause local and general vaccine

reactions.

Assistance was rendered to the Spanish Directorate of Animal Health in controlling the outbreak of African horse sickness in Spain during 1987. The causal virus was identified as Type 4 and 50 000 doses of polyvalent AHS vaccine was made available to assist in combating the outbreak.

VACCINE PRODUCTION

For historic, strategic and economic reasons, the production of veterinary vaccines for farm animals in South Africa is mainly in the hands of the Veterinary Research Institute, whereas the majority of vaccines for the pet and poultry markets are obtained from international companies. A total of 57 different vaccines, 10 diagnostic reagents and four therapeutic sera are manufactured by the institute. About 10% of the total is distributed direct to the consumer. The rest is marketed on an agency basis by various private companies and co-operatives.

TABLE 1 - Vaccine sales in millions of doses over the past seven years

Year	Bacterial	Viral	Other	Total
1981/82	104,1	58,5	0,9	163,5
1982/83	104,9	46,4	0,7	152,0
1983/84	106,5	35,5	4,5	146,5
1984/85	97,8	28,4	3,4	129,6
1985/86	119,6	38,2	3,7	161,5
1986/87	114,2	39,5	3,2	156,9
1987/88	118,0	42,0	4,0	164,0

Vaccine sales fluctuate, mainly owing to climatic and economic conditions. Vaccines were also exported to foreign countries, mostly African states.

TECHNICAL ADVICE TO REGISTRAR (ACT 36 OF 1947)

A total of 386 applications were dealt with by the technical advisers of the Veterinary Research Institute during the year, an increase of 50% over the previous year. Of these, 58 were new applications and the rest amendments and renewals. A total of 231 advertisements were checked for scientific accuracy.

The increase in consumer interest in the safety of chemicals in their environment and in the 'anti-cruelty to animals' lobby, entailed adaptation to new perspectives. The submission of additional relevant data with each application is therefore requested.

The approach to generic products also required rethinking. In the past, full efficacy data for each generic were required by the Department of Agriculture, while the Department of National Health and Population Development accepted the principle of little or no data for generics as far as residues were concerned. A new approach was proposed in which greatly reduced requirements regarding efficacy would be accepted. On the other hand more complete data on manufacturing

processes, quality control and chemical analyses (with particular reference to any impurities) would be requested. As an integral part of the latter propositions, we have visited the manufacturing facilities of some applicants; five such visits took

place during the past year.

To make the enormous amount of very useful information on stock remedies more manageable, a start has been made to computerise all the non-confidential details.

AGRICULTURAL RESOURCE DEVELOPMENT

RESOURCE RESEARCH

Land type surveys

A further four land type maps were printed, which brings the total to 40. It is intended to chart the whole country, on 67 land type maps.

No new memoirs accompanying land type maps were published. The eight land type memoirs published cover 35% of the country.

The computerised data file from which soil and terrain data and soil profile descriptions can be withdrawn was supplemented by a system for the withdrawal of soil analysis data.

Other surveys

Peri-urban soil surveys - Work on semi-detailed soil surveys was continued in the Pretoria-Witwatersrand-Vereeniging complex (PWV). The soil science information collected is made available to town and regional planners with the object of identifying good agricultural land and retaining it for agriculture.

Soil surveys and investigations for irrigation - Reconnaissance and detailed soil surveys are carried out on proposed State and irrigation board schemes to ensure the long-term success of these schemes. An area of 79 000 ha was evaluated on a reconnaissance scale and 4 100 ha on a detailed scale.

Irrigation planning

A report on the planning of the Sarel Hayward Canal area has been completed. The adjacent State land at the Riet River settlement has been evaluated by soil scientists and farm planning has reached a final stage. Owners have been notified of land grants and final maps have been drawn up and submitted.

In the Orange-Douglas area the soil surveys, drainage and peak and quota estimates have been completed and the economic evaluation and determination of optimum farm size submitted for final approval. Negotiations are taking place with the Department of Public Works and Land Affairs regarding the purchase of grazing rights from the holders of such rights on the Bucklands Settlement.

In the Palala River area soil and agro-economic surveys have been completed. All the investigations in the Sundays River area have been completed and according to the agricultural economic evaluation farm size has been put at 55 ha, which includes 12 ha of windbreaks and 40 ha of citrus.

Soil fertility

Because nitrogen fertilisers worth over R300 million are lost annually because they are not utilised, the

causes of such losses are being researched. Fertilisers containing urea and nitrates are very subject to leaching and urea is volatilised as ammonia when it is applied to the surface of soils. The efficacy of nitrogen fertilisers can be improved by placing the fertilisers in the soil.

The analytical methods for mineral nitrogen in soils were evaluated, adapted and published. Incubation studies to predict the nitrogen delivery capacity of soils are progressing favourably. It has been found that soil samples for inorganic nitrogen analyses may be taken any time during the fallow winter months. Samples have to be air-dried soon after being taken.

Simulation models by means of which not only the crop yield but also the nitrogen utilisation by crops can be predicted are being investigated in co-operation with the Republic of China.

Soil chemistry

Advice was supplied to the Department of Water Affairs on matters relating to pollution and two comprehensive investigations in this regard were completed. A method was developed for determining both the solubility and the dissociation properties of various benzoic and cinnamic acids that occur in soils and in crop residues.

In the field of silica-phosphorus reactions and interactions with soils, information was obtained on the extraction properties of various phosphorus extraction methods by means of which anomalies in phosphorus extractions can be explained.

Soil fertilisation

Research on phosphorus and nitrogen fertilisation in the Winter Rainfall Region brought important new information to light. Promising reactions were obtained with rock phosphate at pH 5,3 with acid tolerant crops such as lupins and maize. This points to new possibilities in the use of rock phosphate on a cost effective basis.

When wheat is successively cultivated on stubble fields more than 70-80 kg N/ha and sometimes up to 120 kg N/ha at a rainfall of higher than 350 mm is often applied in the Swartland. Research has shown that on relatively shallow Glenrose/Swartland type soils considerable nitrogen carry-over from one season to the next can occur when N applications are higher than 70-80 g/ha.

It would therefore appear that there can be a considerable carry-over effect in cases where there are high levels of N fertilisation on stubble fields, which has cost implications and might possibly also promote the incidence of grain diseases.

Soil physics

The Section continued work on the characterisation of the state and physical behaviour of the soil, particularly of the plough layer.

A concept was developed to describe soil structure and a mathematical structure model based on this was worked out. From this a model for the soil water desorption curve was developed. This model was validated by applying it to desorption curves for materials ranging from glass beads to heavy clay soils.

The work in tillage was continued. The tilth produced by four primary tillage implements (ripper, disc plough, mouldboard plough, rotavator) in very dry conditions had previously been characterised. This operation was repeated for moist conditions on the same red structured soil. The work provides enough data and insight to make possible the modelling of soil breakup by a share-type implement and the characterisation of the tilth produced.

Simultaneously with this, the microtopography of the four types of surfaces was recorded. This was done using the standard air stereophoto technique in a static close-up mode, digitising the image and computer plotting the result. Contour maps to specified contour interval and scale were produced for each surface.

Soil mineralogy

In the course of the investigation into potassium fixing problems in South African soils, a depletion pot trial was carried out to determine whether any change takes place in the exchangeable potassium status and/or the mineralogy of the soils. After about three months no change was found in the potassium status or the mineralogy. It was established in the course of a laboratory study that potassium is fixed by the soils.

In an investigation in the Western Transvaal it was found that uncultivated soils have a higher clay content than cultivated soils. This indicates clay losses in cultivated soils as a result of wind erosion.

Mother material plays a clear role in phosphorus determination. Cultivated soils on andesite have a considerably lower P content than those on granite. Furthermore, the effect of mother stones on the Ca and Mg status of soils is still apparent even after lengthy cultivations.

Soil-plant-atmosphere-water relationships

The effect on wheat of planting density, period of nitrogen application and irrigation frequency was investigated. The results showed that multiple applications of nitrogen with high frequency irrigation had no advantage with regard to grain quality over a single nitrogen topdressing. Low frequency irrigation and nitrogen administered in

payments over the season did, however, raise the nitrogen content of the grain.

An irrigation scheduling technique for wheat was developed. It makes it possible to determine the period when the wheat should be irrigated by estimating the crop water status and the depth to which the wheat should be irrigated by estimating the groundwater status.

Water utilisation

With the quantification of the water economy of the Glen Shorrock's crop ecotope, results showed, especially during the heavy rains that fell in February and March 1988 (558 mm in 24 days), that basin cultivation can reduce run-off considerably in comparison with conventional cultivation (27% and 44% run-off respectively during the above-mentioned 24 days).

In a study in the Highveld Region on the water-holding capacity of soils it was found that maize and sunflowers can utilise water below the traditional 1 500 kPa value without wilting permanently. This implies that more water is available for plant take up than was originally thought.

Water research

Research carried out with the aid of a rainfall simulator to determine the effect of salinification, electrolyte concentration, exchangeable magnesium and phosphorous gypsum on the hydraulic properties of South African soils showed that the hydraulic properties of a magnesium soil did not differ significantly from those of a calcium soil. The effect of salinification on hydraulic properties depends on the type of clay mineral present, and the electrolyte concentration of the water administered contributes to the rate of crust formation on the surface of the soil. Applications of phosphorous gypsum promote water infiltration in soils that are sensitive to crust formation.

Agricultural meteorology

Different patterns of solar radiation interception are caused by the spatial distribution of maize under dryland conditions. Plants in 2,0 m rows intercept far less sunlight than plants in 1,5 and 1,0 m rows. This tendency can be a drawback with regard to production under good groundwater conditions (low stress), but can be an advantage in drier conditions. The difference in leaf temperature on a plot where there is no groundwater stress and on the treatment plots, as determined with the aid of an infrared thermometer, is a good method of monitoring stress.

Climatically suitable areas for subtropical crops were identified with the aid of the MAPS mapping programme. To date mapping for the following crops has been carried out for the Eastern Transvaal: avocados, granadillas, guavas, macadamias, mangoes, pawpaws, pecans, bananas and tea. A

detailed study (which includes all the possible production areas for the crop in the country) is being undertaken for bananas.

An automatic rain-gauge was set up at Glen in co-operation with the Soil and Irrigation Research Institute. Rainfall data were collected during this period. Information on rainfall intensity and run-off patterns during the flood of February/March indicates that run-off begins at a rain intensity of approximately 25 mm/h, irrespective of the cultivation practices which are applied.

Remote sensing

An ERDAS image processing system was purchased to allow participation in a programme of exchange of data and expertise with CIAM (Cooperative Institute of Applied Meteorology - of the University of Missouri, Columbia USA).

Dr G.E. Johnson of CIAM visited the Soil and Irrigation Research Institute during January 1988 and assisted considerably in the installation of the software supplied by CIAM and with the utilisation of satellite imagery in a natural veld classification project.

Substantial progress has been made with a soil classification project using remote sensing techniques.

REGIONAL DEVELOPMENT

Highveld Region

Soil cultivation - Mulch cultivation studies with maize over four drought seasons have recently been completed. The question arises whether stubble cultivation in maize during droughts is in any way beneficial to the farmer in the Western Transvaal. The greatest utilisation of the maize residues on the land by means of grazing should possibly rather be encouraged.

Subdivision - In the Highveld Region 67 applications for the subdivision and consolidation of agricultural land were received, of which 59 were approved and eight rejected. Last year 87 applications were received.

Land conversion - 282 applications were received and completed for the conversion of marginal crop lands.

Record-keeping of the details and progress of the scheme have been computerised in order to make the central information readily available and to facilitate effective control.

Guide-lines were drawn up for determining the production stability of dryland grain production and cultivated pasture in the Highveld Region. The aim of these guide-lines is to get farmers who are dependent on dryland grain production to consider the risk attached to this type of farming.

Soil classification - The farms belonging to 83 study group members in the Highveld Region with a total surface area of 40 945 ha were

comprehensively classified and provided with soil maps.

Soil conservation - The drought over the last few years restricted the erection of soil conservation works, particularly in the western parts of the Highveld Region. In contrast, the demand for the measuring and erection of conservation structures in the two eastern subregions of Heidelberg and Bethlehem increased considerably. Good progress was again made with overhead run-off-control planning on single farm units.

In comparison with the 86/87 season there was a significant increase in the number of contours that were measured and designed.

A total of R760 340 was paid in subsidies in the region in respect of 423 works.

Karoo Region

Farming trends - The veld conditions over large parts of the North-Western subregion causes concern, although the stocking rate has been largely reduced. It is estimated that the stocking rate at the end of the year under review was approximately 60% of the long-term pasture capacity. The reducing of stock numbers appears to have resulted in an improvement in the quality of animals because poorer types are being sold.

High farming input costs are beginning to have a detrimental effect on the farmer's expansion projects and it is particularly the erection of vital physical facilities that has declined to an alarming extent. In the Middelburg extension area, for example, subsidies were applied for in respect of only 3,6 km of wire fences.

Notwithstanding the temporary drop in the price of mohair, Angora goat farming is still a flourishing branch of the farming industry. The drop in the mohair price and the rise in meat prices now enables goat farmers to adapt their herd compositions and to market undesirable animals as slaughter animals.

Pasture capacities - In the Karoo Region information relating to veld condition, stocking rate and climate is collected from selected collaborators to serve as stocking rate points of reference for determining more accurate pasture capacities. This programme will play a very important role in further refining and revising of the long-term pasture capacities in the Karoo Region during 1990.

Erosion determination - The erosion condition of the veld and lands in the North-Western Karoo is being determined. The information that is obtained will contribute towards the effective implementation of projects for the mechanical reclamation and stabilisation of erosion-prone areas. Similar surveys are being carried out in the North-Eastern and Great Karoo.

Natal Region

Subdivision - 167 applications were made under the Subdivision of Agricultural Land Act and a total of 105 were granted, mainly in the Coastal (43%) and

Midlands (33%) Subregions.

Under the Physical Planning Act a total of 168 applications were made for change of use of land, of which 126 were granted, resulting in a net loss to agriculture of 2 738 ha for the year (excluding land lost to mining and communication).

Land conversion - The scheme to aid farmers to convert cropping land to pastures has resulted in 82 applications for a total of 4 169 ha.

Eastern Cape Region

Soil conservation - Results at the Bathurst Research Station on pineapple lands showed that even a reasonably low application of cover mulch has a tremendous influence on erosion.

Protection of pineapple lands in the Eastern Cape has progressed well and all the 35 farms in the East London and Komga districts have been fully planned, with a total of 90 km of waterways constructed and grassed. The total area involved is 18 300 ha.

Water run-off planning in the Alexandria extension ward has been most encouraging. Farmers have constructed 41,3 km of waterways during the past year, which is a complete turnabout from the previous situation where 21 farmers had received personal directions because of the lack of protection works on their cultivated lands.

During the year under review 54 new plannings and 229 replannings were carried out in the Eastern Cape Region. This is an increase of 21% as against the previous year.

Although there was an increase in the number of farms that were planned last year and the number of works that were approved, there was again a reduction in the number of works that were erected. This decrease can be attributed mainly to the financial situation of the farmers and the prices of material which continue to rise, while subsidy tariffs have remained unchanged over the past four years.

During the year under review 357 works were erected with the subsidy value of R417 099.

Transvaal Region

Farming trends - In order to combat the bush encroachment problem in Thabazimbi, boer goats are being kept in increasing numbers.

At Brits the table grape industry is receiving more and more attention. The producers fill a gap in the market during November. Paprika is being planted increasingly and vegetables, wheat, sunflowers and cultivated pasture are given preference on the heavy soils.

In the Mid-Transvaal subregion overall dairy production decreased (withdrawal of industrial milk farmers, only a few of whom converted to fresh milk), but there was a significant increase in sheep production (especially dual purpose sheep). Also, less maize is being grown. It is being replaced mainly by cash crops and, on a small scale, by pastures.

As a result of the long droughts stock numbers decreased considerably in the Northern Transvaal.

Farmers are very interested in the establishment of cultivated pastures. As a result of the droughts farmers are becoming increasingly aware that dryland crop production in the Northern Transvaal is risky.

During the year under review 27 farmers in the South-Eastern Transvaal applied to establish a total of 1 905 hectares under a perennial grass pasture. This is only 0,64% of the total area currently under summer cereal crops. In this area wool production is increasing to such a degree that Ermelo is at present the district which produces the most wool in the country.

In the Lowveld the production of subtropical crops such as mangoes, avocados and bananas is showing an increase. It would also appear that tea production can be further expanded.

Soil type and other surveys - Approximately 80% of the Transvaal region is covered by land types, although all the information has not yet been computerised or published. The entire region is divided into 145 RHFA's.

The Designated Area was identified as the highest priority and a map was compiled for the 10 km zone on which all farms and subdivisions were identified. A start was also made on the 50 km zone.

Potential investigations for the subdivision or changed use of agricultural land dropped from 560 applications in the previous year to approximately 470 applications.

A comprehensive investigation was carried out into the ownership of land in the Buurmansdrift irrigation area.

Irrigation planning - To supplement the Regional Development Plan an irrigation plan was drawn up. In addition to maps showing water demand and availability, maps were also made indicating the localities of Government water schemes, irrigation boards, Government water control areas and subterranean water control areas. Tables were made for each magisterial district in which the available information on irrigation is summarised. Maps of sub-catchments have also been drawn up.

Soil conservation - Works with a total subsidy value of R726 770 were completed in the year under review. Almost 60% of these are for water-ways.

Free State Region

Farming trends - The scheme for the conversion of marginal land to cultivated pastures which was established during the year under review aroused great interest. 240 applications were received and 6 700 ha have already been established. The most extensive plantings were in the Bechuanaland area. In the Mid-Free State mainly Smuts finger grass is planted, and feed sorghums are the most popular in the Southern Free State and Griqualand West.

Cotton farming continues to expand in the Vryburg district and it is estimated that the crop is established on 6 000 ha at present.

There is a tendency to plant less maize and to replace it with wheat, sunflowers and cultivated

pastures. The area under maize in the Winburg district is at present only approximately 50% of the normal area and reductions of 30% to 40% are being experienced in Theunissen and Virginia.

The completion of the Sarel Hayward Canal resulted in new possibilities for irrigation. Traditional stock farmers are now becoming involved in the field of intensive irrigation farming.

In Gordonia there is a great deal of concern with regard to parts of the dune veld that were completely denuded of all vegetation.

The injudicious use of subterranean water is a cause for great concern and is a matter which should receive serious attention.

Yield norms - Yield norms per RHB are determined for cultivated pastures in the Bechuanaland subregions. Yield norms for beef production systems are also determined in the Bechuanaland subregion. A computer programme has been developed for the calculation of the production per hectare. Yield norms for small stock production systems (meat and wool) are being collected in the Southern Free State subregion.

Data base systems - A conceptual framework for a computerised agricultural resource data base is being developed for the Free State Region. A farmers' data bank which will contain information in respect of farming units in the Free State Region is also being set up.

Soil conservation research - There is an urgent need for soil conservation research in the region. Investigations were carried out into adapted grass cover in water-ways and into the functional efficiency of existing water-ways.

The floods of February and March 1988 not only caused damage to irrigation lands in the riparian areas of rivers, but also caused tremendous damage to lands where dryland cultivation was being applied. However, it is remarkable that there was not much erosion in the areas on which water run-off control plantings were carried out and applied.

Damage as a result of wind erosion in the Free State Region is incalculable and is increasing dramatically. Since the combating and prevention of wind erosion involves various disciplines, the initiation of such a programme is necessarily being delayed.

During the past year 1 043 conservation works in the Region were completed, on which subsidies of R1,1 million were paid out.

Bush control - The bush control scheme applies mainly in the Northern Cape and more specifically in the Vryburg area. Veld improvement is noticeable on farms where the bush has been eradicated. During the year under review 197 applications were received in respect of bush control on 77 790 ha. This represents an increase as against the previous year.

Winter Rainfall Region

Soil investigations - During the past year 284 farm visits were undertaken and 2 292 profile descriptions were done in the Winter Rainfall Region.

Other investigations - The Region was involved in 22 investigations relating to unsuitable roads and

18 investigations relating to the rezoning of agricultural land and comments were made on seven structural plans of towns.

Resource data bank - The various banks are continuing to be successfully loaded. The creation of this unique system of data storage and utilisation has aroused so much interest throughout the country that during November 1987 the Region held a symposium for three days for interested parties from all regions and institutes. The comments received from those attending the symposium were very favourable.

Investigations, Act 88 of 1967 - Agricultural extension officers from the Region investigated eight applications for gravel pits and sand utilisation and 18 further investigations were concerned with the changed use of horticultural land in the Philippi area.

Applications, Act 70 of 1970 - A total of 149 applications for subdivision of agricultural land were received in the Winter Rainfall Region.

Soil conservation - During the year under review in the Winter Rainfall Region there was a greater increase in the number and financial value of soil conservation works that were approved and completed than in any previous year. The number of completed works rose from 892 in the previous year to 1 232 in the current year i.e. an increase of 38%, and the financial value rose from R1 834 114 to R2 035 851, which represents an increase of 11%.

Protection works on land (contour walls, storm-water drains and water-ways) still form the most important part of the mechanical protection works in the Winter Rainfall Region.

However, the low percentage of pasture utilisation works (38%) that have been completed is disappointing. This is mainly attributable to a lack of capital on the part of farmers after the years of drought and the low subsidy rate.

Control of weeds - The incidence of nasella tussock grass is gradually decreasing in the Winter Rainfall Region. Unfortunately there are still areas on the Groote Schuur Estate which are heavily infested and where it will be very difficult to eradicate this grass. The tussock grass infestation at Swellendam is under control.

Scotch thistle (*Cirsium vulgare*) is becoming a problem on Table Mountain and on some farms around Durbanville and Swellendam. Spiny cockle bur (*Xanthium spinosum*) has obtained a foothold in various parts of the Winter Rainfall Region. Large cockle bur (*Xanthium strumarium*) is still a problem along the Berg and Breë Rivers.

Sesbania (*Sesbania punicea*) is still generally found along river courses throughout the entire Winter Rainfall Region. The Sesbania snout beetle, *Trichapion lativentre*, which attacks the flowers, has already given good control in the areas where the beetle has been released.

The bugweed (*Solanum mauritanum*) is also widely distributed on town plots in the Winter Rainfall Region, particularly on the slopes of Table Mountain.

Farmers being persuaded to promote optimum grazing utilisation and animal production



An example of stubble mulching on pineapple lands in the Eastern Cape



Major conservation works constructed in dongas to control erosion



The effect of different methods of flood irrigation on vines is determined



The moisture content of vineyard soil being determined with the aid of a neutron moisture meter

DEVELOPMENT OF ENTREPRENEURS

PROGRAMMED EXTENSION

Highveld Region

At the end of the year under review there were 70 active study groups with 864 members involved in programmed extension in the Highveld Region. The majority of these study groups function as crop and grazing study groups, which try to promote optimum crop practices and grazing and veterinary management practices by means of extension. This year the emphasis was particularly on the implementation of the National Grazing Strategy programme and lectures on the improvement of natural pastures received special attention.

The 70 study groups held 469 study group meetings this year with a total attendance figure of 4 663. The majority of the study group meetings were devoted to pasture or animal husbandry matters. A total of 338 lectures and discussions were held by officials on relevant crop and grazing science topics. In the process, 27 meetings of farmers' associations, attended by 523 farmers, were also addressed.

Ten information days were held and attended by 506 farmers and 18 farmers' days were held which were attended by 602 farmers. Two beef cattle courses and two dairy courses were held and attended by 65 people.

Although farming conditions improved for most of the Highveld farmers this year, most of the study group farmers in general could not follow optimum crop practices as a result of a weakened financial position and a lack of funds, and they had to make drastic cuts in inputs such as fertiliser, pesticides and herbicides.

The Highveld region continues to devote a great deal of attention to the training of farmers in order to improve their knowledge of agricultural resources so that they can evaluate the resources themselves. A total of eight resource courses were held which were attended by 117 study group members.

It was particularly the following veterinary and grazing science aspects which received attention this year: grass identification, pasture planning, pasture pressure, feed flow planning and correct pasture management. The inclusion of woolled sheep, in particular, in crop farming also received attention.

With regard to crop farming the following aspects in particular received attention: soil potential, plant nutrition, weed killers, cultivation, pest control, the stand of plant, crop and cultivar choice, incorporation of alternative crops and optimum resource development.

Karoo Region

In extension programmes emphasis is placed on the conservation and optimum utilisation of resources. Aspects that were dealt with are grazing utilisation, grazing capacities, the drought aid scheme, drought forage crops, cultivated pastures, general farming management, etc. Farmers are involved in the extension programmes by means of conservation committees, liaison groups and the creation of permanent audiences. Mini farmers' days and veld days are organised and the concept of conservation is a high priority of conservation committees.

Veld management - Study groups were set up in the various areas of the Karoo region and these groups strive to attain improved field management and establishment of drought crops. All these groups are very active.

About 1 200 ha of saltbush, 900 ha of spineless cactus and 150 ha of American agave have already been established in the *North-Eastern Karoo*.

Some farmers have at times established as much as 10 000 saltbush plants per day. Exceptionally good rain considerably facilitated the establishment. In the *North-Western Karoo* at least 40 farmers started with nucleus plantings of saltbush.

Natal Region

Beef - Two beef courses and beef study group meetings were used to provide farmers with new information. In terms of the National Grazing Strategy over 30 farmers' days were addressed on managerial topics relating to beef production. To provide better information on systems of management a project was initiated to examine patterns of defoliation and animal performance in different systems.

Sheep - Three woolled sheep task teams were appointed for three different areas to support the Regional Woolled Sheep Production Committee. These teams were very active and devoted their attention to extension and research needs, resulting in farmers' days and the development of research facets on the Dundee Research Station.

Grazing - Further progress is being made in the implementation of the National Grazing Strategy. More than 39 farmers' days were held. These received wide acclaim from farmers and field staff. It became apparent that veld management should receive further intensive attention.

Eastern Cape Region

In the *Border subregion* good progress is being made with optimum pasture utilisation and animal production. In the Queenstown extension district

nine permanent audiences were created. In addition to this eight field days were held. In the Albany and Bathurst extension districts three pineapple study groups are active under the supervision of the extension officers and their co-workers.

In Humansdorp, Uitenhage and Port Elizabeth three facets have been registered that are aimed at the fynbos veld which is being increasingly used by Angora herds. Up to now there have been no norms and techniques in this regard.

In the *Stutterheim* ward there has been a great deal of progress with a wattle control programme. The scope of the infestation was determined and a comprehensive demonstration of eradication methods was demonstrated on one plot.

Furthermore an active potato work team has been established in the *Algoa subregion*. This group meets regularly and carries out demonstration trials. Results obtained by this working team are published at farmers' days, at study group meetings and at farmers' associations.

Transvaal Region

Over the past few years farmers have been involved in various extension activities with the help of farmers' associations, study groups, conservation committees, farmers' days, courses, panel discussions and other activities. There were also 337 meetings involving more than 9 000 farmers. Advice was also provided through farm visits and interviews and information was disseminated by means of newsletters, radio talks, etc. The extension staff were also involved in various investigations and situation determinations.

Programmes are aimed at the optimum utilisation of resources. In the *Western Transvaal subregion* field control programmes apply in six conservation areas. Farmers' knowledge of field and sensible field management practices are extended and they are made very aware that -

- six camps per herd are necessary;
- the principles of control selective grazing should be applied; and
- the prescribed long-term grazing capacity should not be exceeded.

Various water run-off control plans are being done and farmers are encouraged to erect and maintain conservation works. However, as a result of the continuous drought, farmers are in a poor state of mind and are financially not able to make contributions.

In the *Mid-Transvaal subregion* a survey was carried out among peach farmers and a determination was made in respect of irrigation practices.

In the *Lowveld* study groups are active in respect of various commodities. The cotton study group at Tzaneen showed that the yields of 2 000 kg to 3 000 kg/ha can be increased by the more effective utilisation of irrigation water and fertiliser.

Free State Region

Programmes are being launched in the Free State Region in order to attain the objectives of the National Grazing Strategy and are being carried out in accordance with the principles of the National Extension Strategy. In the *Mid-Free State* there are eight extension facets which are actively involved in the improvement of natural grazing. Group meetings, farmers' days and courses are held in respect of field management, field condition determination, resource classification and farm judging.

Programmes are supplemented by farm visits, letters of advice, pamphlets, radio talks and interviews. Farms are evaluated in order to identify farmers who apply good conservation practices. Recognition was given to 39 farmers who were awarded certificates.

Approximately 1 300 ha of Smuts finger grass were established during the year under review in the Brandfort, Excelsior, Theunissen and Virginia districts and this brings the total establishment of this grass to 3 100 ha.

In *Griqualand West* various extension programmes are being undertaken to promote stock and game farming. A total of 46 group meetings were held which were attended by 867 farmers. Demonstrations and lectures were held for groups of farmers, farmers' associations and conservation committees and seven farmers' days were held.

In the *Southern Free State* 90 group meetings were held and attention was given to grazing management, cultivated pastures, supplementary feeding during drought, veld composition, livestock management, the reclamation of bare patches, etc. A collaborator at Reddersburg established 40 ha of land of teffgrass and *eragrostis curvula*, and this should provide valuable pasture during the winter and early summer. At Smithfield 83 farmers have already been convinced to keep financial records.

The serious drought drastically impeded planned extension programmes in the *Gordonia area*. The conservation committees in this area in fact recommended that all proposed programmes should be postponed until after good rains, when the farmers' state of mind should be more positive.

In the irrigation areas attention is being given to various aspects of viticulture. Table grape production has developed practically overnight into an important industry in the area. All the producers are visited on a group basis and individual basis to inform them with regard to table grape cultivation.

In the *Bechuanaland area* 55 group meetings were held which were attended by 702 farmers. Farmers' associations and conservation committees were addressed and three farmers' days were held. The topics covered dealt mainly with the promotion of livestock and game farming practices and included pasture control, bush encroachment and meat production.

Winter Rainfall Region

In the *North-Western subregion* a total of 700 000 old man saltbush plants were planted by 36 farmers. This brings the total plantings in this subregion to more than four million. Co-operative demonstration plots are being established on 10 collaborators' farms. In the case of two of these collaborators the plots have already been grazed and an average of 1 400 sheep grazing days was obtained with a single summer grazing. The saltbush planter which was designed by extension staff themselves has been very successfully used for the establishment of old man saltbush plants.

Eight field days were held during which farmers were instructed in the principles of grazing management and received information on the appropriate properties and general names of the most important pasture plants. A total of 280 farmers were involved in these meetings.

In the livestock areas of the *Little Karoo* the emphasis is mainly on the cultivation of drought forage crops. Approximately 311 ha of old man saltbush were planted during the year by 41 farmers. A pilot trial with ostriches on saltbush pasture plus an energy supplement indicates a possible saving of up to 50% of forage costs.

In the horticultural areas of the *Little Karoo* the need for correct soil preparation and establishment techniques in long-term crops is being propagated. Soil science investigations with a view to the provision of establishment advice were carried out for 67 farmers on 491 ha.

In the *Boland subregion* there is also much emphasis on establishment techniques for long-term crops by means of, *inter alia*, the correct choice of resource and preparation. A total of 413 profile investigations were carried out on 466 ha of land with a view to establishment. The table grape block competition in the Hex Valley is regarded as a very effective way to convey the extension message.

In the *Swartland area* attention was given to improved small grain production techniques, the promotion of higher weaning percentages in sheep, the improvement of management techniques among dairy producers and to persuading farmers to apply improved weed control techniques.

In the *South Coast subregion* good progress is being made with programmes on the chemical control of annual invader grasses in dry land legume pastures, in order to improve the profitability of dairy herds by keeping records and programmes relating to the implementation of management systems which will lead to higher weaning percentages in sheep.

Farmers are also being persuaded to include lupins as a rotation crop in their farming systems and improved production techniques for onion farmers are encouraged.

TRAINING

Training facilities for prospective farmers are available at the five colleges of Agriculture of the

Department of Agriculture and Water Supply, namely Cedara (Natal Region), Elsenburg (Winter Rainfall Region), Glen (Free State Region), Grootfontein (Karoo Region) and Potchefstroom (Highveld Region). Table 1 shows the student numbers at the various colleges.

TABLE 1 - Student numbers at colleges of agriculture in 1986/87 and 1987/88

	1986/87	1987/88
Cedara	124	129
Elsenburg	195	189
Glen	138	135
Grootfontein	105	106
Potchefstroom	146	142

Apart from the formal diploma course, the colleges also present a variety of short courses.

At the Potchefstroom College of Agriculture attendance at the short courses in milk production, beef production and sheep production was substantially higher than previous years. The veld and pasture day that had to be cancelled the previous year due to a lack of interest, was exceptionally well attended this year. This is attributed to increased interest in the incorporation of livestock farming into risky cropping enterprises.

AGRICULTURAL INFORMATION

Popular publications

During the year under review 175 new and revised leaflets were published in various series, and about 110 leaflets were reprinted unchanged. A further 48 information documents on crop production in the summer rainfall area were also published and distributed.

A total of 120 issues of newsletters were edited and prepared for printing. In addition 96 Agricultural Reports of the foreign offices were printed here. A further 155 publications appeared as reports, manuals, lectures and technical and information bulletins. Departmental organisations were also continuously advised on compiling and planning programmes, newsletters, brochures and special publications.

Scientific publications

Articles - During the year under review 90 articles were received for publication - 33 fewer than the previous year. Including a carry-over of 55 articles, the editorial committee dealt with 145 articles, 115 of which were approved for publication. Of these 99 were published during the year under review, compared with 61 in the previous year.

In addition the Proceedings of the Eighth Symposium of the Nematological Society of Southern Africa were published in Volume 19(2) and the Proceedings of the Twenty-sixth Congress of the South African Society for Plant Pathology in Volume 20(1).

Onderstepoort Journal of Veterinary Research

- The following editions appeared: Volume 54(2) with 13 articles, Volume 54(3) with 61 articles, Volume 54(4) with 23 articles and Volume 55(1) with 17 articles.

A total of 114 articles were published compared with 50 the previous year.

Other scientific publications - The following scientific publications appeared during the year under review:

Technical Communications No. 209, 210, 211, 212, 213 and 214; Entomology Memoirs No. 69, 71 and 72; Flowering Plants of Africa Vol. 49 parts 3 and 4; Bothalia Vol. 17(1) and (2); Flora of Southern Africa: Bryophyta 1(2); Memoirs on the Natural Agricultural Resources of South Africa No. 8.

News service

About 50 editions of *Agricultural News* appeared during the year under review, with an average of 12 pages per issue. The emphasis was on land conversion, financial support in both drought and flood-ravished areas and the National Grazing Strategy. Events and changes within the Department were reported far and wide such as particulars concerning additional financial assistance to farmers in the summer rainfall cropping areas, the game industry, the effect of high-recovery coal mining on the agricultural industry and the reasons for creating an agricultural research council. The media - especially the rural press - make increasing use of reports printed in *Agricultural News*.

Press releases - About 50 press releases were made during the year, with excellent results.

Radio reports - In addition to the nearly 21 000 lines broadcast in both languages for six days of the week, news bulletins were also sent to Radio Oranje on a daily basis. A regular weekly calendar of events was also broadcast for farmers on Saturday mornings. The calendar and important daily news items are also supplied to the morning television service. Both media made regular use of the items.

About 300 radio bulletins, each about 5 minutes long, were broadcast in both official languages, which means that some 1 500 minutes or 25 hours of broadcast time was used by each of the languages.

Calling All Farmers

Renewal and restructuring in agriculture featured strongly in this year's programmes. Important developments such as the National Grazing Strategy, the Land Conversion Scheme, financial assistance to farmers and the work of the Jacobs Committee received a lot of attention. Thanks to an increase in regular contributions by the research institutes, more programmes with a practical vein could be presented. Efforts were also made to ensure that the programmes increasingly reflected the extension programmes of the different regions.

Close links were also maintained throughout the year with organised agriculture in the form of a weekly talk supplied and presented by Media Services of the SAAU and reports and interviews concerning provincial and national commodity conferences and congresses.

The activities of the various marketing boards also received attention by means of interviews with their senior officials regarding price and supply situations.

Other subjects receiving particular attention were: market orientated grain production, flood damage relief, environmental and wildlife conservation, livestock health, labour relations and the training and well-being of farm workers.

Various international congresses which took place in the Republic, such as the World Avocado Congress and the 6th World Congress of the Pinzgauer Cattle Breed, were also covered.

Audio-visual services

A highlight of the year under review was the commissioning of new video-editing apparatus. This equipment enables the Department to produce inserts for the SABC and video programmes of broadcast quality for training.

Eighteen contributions of three minutes plus were supplied to the SABC and were used in the morning television service's agricultural programme.

Two training programmes - 9 and 18 minutes respectively - were also completed on video. Four sound slide programmes were completed, duplicated and distributed. Twenty-nine series of the existing slide programmes were duplicated and issued on a permanent basis. The total number of slide series issued permanently now comes to 49. A total of 412 slide series are out on loan.

Colour slides continue to be popular and 712 slides and 50 colour and black-and-white negatives are out on loan. Some of the existing slide series are also available on video tapes. Twenty-one video tapes are on loan, and 44 have been issued on a permanent basis.

Documentation Centre

This year the Documentation Centre again proved that it is one of the most important links in supplying scientific information and the demand for obtaining information via this type of service is still increasing.

Although the SADAL service was originally introduced for departmental researchers and extension officers, more than a hundred users from private institutions now avail themselves of the service. These institutions include the various Marketing Boards, the Fertilizer Association, university lecturers and post-graduate students, other state departments, CSIR researchers, co-operatives, etc.

Due to the ever-increasing cost involved in the purchase of the information tapes, printing and

paper costs and mailing costs, all new and some of the older profiles have been recompiled to ensure both higher relevance and a smaller number of retrievals. This proved to be very successful and users welcomed the step. In future the scaling-down of information tapes for searches will have to be considered - without withholding any information or sacrificing quality.

CAB database - This database supplies in more than 90% of the researchers' needs. Ample use is made of this databank since it now stores just over 2 million documents. Concerning retrospective searches, some 300 profiles were compiled during the year under review and retrievals from these were mailed to researchers. An upgrading of the search, retrieval and printing programmes resulted in substantial savings on paper, and it was also possible to switch from a 3-monthly SDI service to a 2-monthly one. This leads to 'a maximum improvement in the topicality of the retrieved information.

The number of participants in the Department's selective dissemination information service increased by a further 50 users to about 900. Because the annual average number of retrieved documents per profile was further reduced to about 89 due to increased efficiency, some 80 000 documents were dispatched to SDI users.

Together with the nearly 40 000 documents retrieved for retrospective purposes, this means that from the CAB database alone, a total of 120 000 documents were retrieved and made available to researchers during the year under review.

Food Science Technology and VITIS abstracts databases - The wine database continues to be of great assistance to researchers working on viticulture and oenology. Although only some 40 SDI users use the two databases, about 6 000 documents were retrieved and dispatched to researchers during the year under review.

Agricultural libraries 1987/88

The extent of the services of the agricultural libraries is reflected in the fact that there are now 24 libraries. Two new libraries are planned. A start has already been made to collect documents for the Grassland Research Centre and the Lowveld College of Agriculture.

Price increases, the low value of the rand and boycotts by publishers make it difficult to extend library collections. Inter-loan statistics indicate that co-operation and better utilisation of existing information sources have improved. Statistics show that during the year under review 17,6% more inter-loans were requested by agricultural libraries from other libraries while 21,3% more queries were received from other libraries. The importance of the collections of agricultural libraries for the country as a whole is endorsed by the fact that 20,4% more inter-loan requests were received than were requested

from other libraries. Library personnel answered nearly 55 000 reference queries during the year under review.

Library personnel act as liaison officers between agricultural researchers and the Documentation Centre (SADAL). During the year under review 215 articles, references to which were supplied by SADAL, were ordered from the CAB after they could not be traced in the RSA.

Computerisation of specific library functions are receiving attention. Once the necessary links have been established and the apparatus can be supplied, library users will be able to expect a quicker service.

AGRICULTURAL ENGINEERING SERVICES

Agricultural implements

Mechanisation-related problems - A survey was carried out in certain districts in the summer rainfall field-cropping areas to identify the latest trends in agricultural mechanisation and the latest mechanisation-related problems. It became apparent that producers require assistance with the implementation of new technology and practices and with financial decisions regarding agricultural mechanisation. It was also found that there are possibilities for the manufacture of agricultural implements at various levels, including a "do-it-yourself" approach. The Directorate is following these matters up.

Mechanisation planning - The possibility of using personal computers as a decision-making aid with regard to mechanisation is being investigated. Standard software is being used for the analysis of mechanisation systems. Aspects such as large versus small implements and replacement policy are being investigated.

Soil cultivation - An instrument for use in pasture reclamation has been developed and is being evaluated under field conditions. The implement is based on a mounted one-way disk harrow from which some disks are removed, while others have sections cut out of them. Small furrows are then formed in the veld; moisture and grass seeds collect in the furrows and vegetation becomes re-established.

Tractors - A number of confidential tests were carried out and firms were assisted with research on power losses and cooling of their tractor models.

Planters - Confidential tests were carried out on a hand planter for the seeding of veld grasses and subsequently on a mechanised version as well. Suggestions for the improvement of the planter were made to the manufacturer.

Spraying equipment - A computer-assisted technique for the evaluation of droplet spectra and degree-of-leaf-cover was successfully developed and is being applied in research pesticide application techniques.

Materials for agriculture - It is now possible to make recommendations, based on research by the

Directorate, on the choice of materials for heat treatment procedures for soil-wearing parts.

Horticultural-mechanisation - An investigation of mechanical damage of potatoes has been completed and a video film has been produced, in co-operation with interested bodies, as an aid in transmitting technology in this regard. Structures for use in growing kiwi fruit have been studied and a manual has been published.

Technology transfer - Manufacturers of agricultural machinery, co-operatives and producers were given advice during courses, lectures and visits on the purchase, application and use of agricultural implements.

Agricultural structures and related facilities

Dairies and dairying equipment - The official testing programme for milking machines has been completed. Confidential reports have been discussed with each of the nine firms that participated. Extracts from these reports are now being collated.

The study on labour in milking parlours has been completed and the report is available. Additional plans for milking parlours have been drawn up and a simple system is being developed.

Beef cattle housing and handling - Information on beef cattle handling has been incorporated in a manual that will probably be available at the end of 1988. Several confidential test reports on cattle scales have been compiled; a technical manual on animal behaviour has also been compiled with a view to the planning of handling facilities.

Dealing with animal waste - Separating the solid matter not only makes it possible to make better use of animal waste as a plant fertiliser but also means that smaller manure dams are required. Further improvements have been made to the experimental manure separator and about 65% of the solid matter in the sludge can now be separated.

Solid matter such as broiler manure or matter separated with the aid of a separator can be very effectively composted by means of artificial aeration. Problems are still being encountered with the composting of cattle manure.

Facilities for small stock and poultry farming - Pamphlets are being compiled, in co-operation with the National Wool Growers' Association, to give wide publicity to modern shearing shed designs. Sheep flow problems are still being encountered with the intake to the experimental round sheep dip. A considerable amount of research and development is also being carried out on the rearing of ostrich chicks in a controlled climate.

Pig housing - Owing to problems with the opening and closing of windows for ventilation control, blinds have been developed that may be up to 80 metres long and are controlled from a single point by means of a pulley. An improved farrowing crate has also been developed.

Animal feed processing - The planning of feed processing systems for the Animal and Dairy Science Research Institute at Irene and the Nooitgedacht

Research Station at Ermelo has revealed that, owing to the high cost of electronic scales, there is a need for cheaper methods of determining the mass of the various materials in a feed ration. The Directorate is now investigating a volumetric method of determining quantities of materials that the farmer could apply in practice.

General - Information on agricultural structures and facilities is supplied to farmers, study groups, students and companies on a continuous basis.

Climate-controlled structures and facilities - Two mite-proof greenhouses were designed and constructed to store virus-free plants belonging to the Citrus and Subtropical Fruit Research Institute at Nelspruit. The greenhouses were also equipped with an improved evaporation system that functions more efficiently under hot conditions.

The virology greenhouse of the Vegetable and Ornamental Plant Research Institute at Roodeplaat was also equipped with a cooling system that entailed considerably less capital expenditure.

The first high light intensity growth chambers capable of being built locally were designed and a contractor will be appointed shortly. In the past high light intensity growth cabinets were imported from the USA. Local manufacture makes it easier to obtain spare parts and reduces expenditure on foreign exchange.

Grain silos - During the year under review technical advice was given in respect of the following grain storage projects:

- The upgrading of facilities at nine existing silos. In addition to replacement of obsolete handling equipment to speed up the intake rates, grain driers, sidings, weigh-bridges, aeration equipment and temperature monitors were also upgraded.
- An intensive study of the cost and business economics aspects of upgrading.
- Twelve final inspections of completed projects.
- An investigation into the replacement of weigh-bridges at virtually all silos, the existing weigh-bridges being too short for the longer modern trucks.

Research on agricultural energy

Sunflower oil as fuel - With reference to results obtained with two tractors run on an ester/diesel mixture on a farm in the Rustenburg area, no fuel-related problems are expected with an ADE 236 engine under similar conditions. The fuel was stored and handled in the usual way on the farm. General applicability under colder climatic conditions and with other makes of engine has yet to be confirmed.

A record total of 680 service hours was achieved in the laboratory under simulated load conditions on a mixture of sunflower oil and diesel, with an additive, before problems (abnormal smoking and loss of power) started to develop. Further improvement of the additive, which was specially developed for the fuel sunflower oil, is being researched by the participating firm.

A potential oxidation stabiliser, whose purpose is to extend the storage life of ester fuel, has been identified. The long-term effect of the stabiliser on the life of the engine is being investigated.

Hydro energy - A revised design manual on the use of a standard centrifugal pump as a hydraulic turbine has been compiled. Relevant data on suitable pumps available on the local market are summarised in the manual.

A design procedure for the use of an axial flow fan as a hydraulic turbine has been developed. The need for such a turbine is felt at high rates of flow where the pressure is very low and the centrifugal pump or cross-flow turbine is not suitable.

Irrigation and drainage engineering

Irrigation equipment - Evaluation of sprinklers, drippers, filters, valves and microjets is carried out in the laboratory on a continuous basis. Performance reports are compiled on the basis of the results and technical data are supplied to designers and firms. The information fed back to the manufacturers is of value in promoting improved development.

Irrigation systems are evaluated in the field with the aid of a mobile evaluation unit in order to observe the overall performance of systems.

Technology transfer - Farmers were advised concerning the choice and planning of new systems, the consideration of quotations and the solving of problems in irrigation systems.

Several lectures and courses on technical aspects of irrigation were also presented at symposia and farmers' days.

Soil conservation engineering

Rainfall simulator studies - A sixth rainfall simulator is under construction. One of the two simulators in the Natal Region has been transferred to the Eastern Cape Region, where soil losses and run-off will be studied under natural veld conditions.

Research on the effect on conservation of specific practices in orchards in the Eastern Cape and in pineapple fields in Natal and the Eastern Cape is continuing.

Rainfall simulator demonstrations and seminars were also presented to interested persons in the self-governing territories.

Soil conservation research - Research is being carried out with the object of arriving at mathematical relationships to relate the size and shape of stable dongas to the floods, soil type, climate and topography of the catchment. The effect of weirs on dongas is also being studied. These results will be used in future to plan catchments for soil conservation works.

Technical supervision - 4 024 works were completed during the year under review and R6,5 million was paid out in subsidies in respect of these works. The following table shows the progress made in comparison with the previous year reviewed.

	1986/87		1987/88	
	Number of works	Subsidy paid out (Rand)	Number of works	Subsidy paid out (Rand)
Contour banks	2 316	2 507 994	2 367	2 275 925
Soil conservation works	160	831 056	151	942 348
Erosion hedges	145	45 804	108	60 000
Subterranean drainage works	337	1 050 033	766	1 649 780
Camp hedges	1 855	432 006	1 418	263 810
Stock-watering points	804	779 719	547	460 188
Flood relief scheme				
Ordinary	16	18 536	242	307 913
Disaster	29	9 868	-	-
Bush control	299	298 155	425	501 760
Total	5 961	5 973 171	6 024	6 461 724

Two technical manuals were printed and distributed to the Regions. Several lectures on soil conservation were delivered at the University of Pretoria.

Key soil conservation works - Reconnaissance reports on the conservation condition of two catchments were compiled; recommendations were made on the placement of key soil conservation works in eroded watercourses. The reports resulted in the planning of 14 structures and 25 km of waterways.

In the Karoo, the Eastern Cape, the Highveld and the Free State Regions teams of workers erected 71 km of fencing in order to fence off eroded watercourses and constructed 20 km of waterways.

In addition to these routine operations, a team of workers at the Messina Experimental Farm of the Citrus and Subtropical Fruit Research Institute carried out the following development projects:

- The building of a storage dam with a capacity of 1 million cubic metres
- Deforestation of 50 ha for citrus
- Clearing for a 20 km fence
- Digging trenches for and laying 1,5 km of pipe line
- Building a 2,5 km tarred area and access road.

Building costs for the above amounted to R250 000,00.

Production by the construction teams is shown in the following table.

Existing structures repaired				New structures erected			
Under construction		Completed		Under construction		Completed	
Number	Value	Number	Value	Number	Value	Number	Value
3	R67 000	11	R77 184	9	R350 900	24	R782 036

Electrical and electronic engineering

The commissioning of a new instrumentation laboratory with modern equipment and temperature-controlled calibration conditions is a reflection of the need for research and development in the field of electronics in agriculture.

Electronics and instrumentation - An electronic diesel fuel counter which shows the fuel consumption of a tractor on a liquid crystal display every five seconds, and is accurate to within 1 cm³, has been developed for demonstration purposes.

An electronic leaf strength indicator has been developed and built with the object of determining the tensile strength of different grass varieties. Several other projects, including projects on temperature, ventilation and water flow control systems, have also been completed.

Farming development

A total of 62 084 copies of engineering publications were dispatched to interested persons. 10 380 test reports on agricultural implements, tractors and related equipment were supplied.

GOVERNMENT WATER SCHEMES AND WATER DRILLING SERVICES

Irrigation boards

The Department of Agriculture and Water Supply was responsible for the technical administration of the 258 White own affairs irrigation boards, with a

total scheduled area of 338 587 ha. 27 irrigation boards were engaged in constructing works, 18 of which were completed in the course of the financial year. Nineteen new works were approved, one of which was a White Paper case.

A total of R10 182 million out of an allocated amount of R10 235 million was spent. The regional engineers maintained good relations with the irrigation boards concerned and the transfer of responsibilities from the Department of Water Affairs was completed.

Thirteen new irrigation districts were established during the year under review, and work in relation to six proposed irrigation districts is in progress.

Water drilling services

This service, which has been operated by the Department since 1985, when it was taken over from the Department of Water Affairs, makes provision for the drilling of boreholes for domestic water consumption and for animal drinking water in the agricultural sector and for the subsidising of drilling by State drills or private drilling contractors.

The service has come to be highly rated by the farming community, especially since June 1986, when farmers in the Designated Areas were assisted through a special aid scheme.

During the year under review State drills were responsible for drilling 1 907 holes, with an average depth of 89 metres and a total daily water yield of almost 235 000 cubic metres.

During the year under review subsidies paid to private drilling contractors totalled almost R10 million.

BOTANICAL AND PASTURE RESEARCH

BOTANICAL RESEARCH

Much progress has been made on several fronts during the year under review.

The development of a computerised control system for the National Herbarium has already produced major benefits. Together with PRECIS (National Herbarium Computerised Information System), this control system places the National Herbarium in Pretoria at the forefront of computer applications to herbarium collections world-wide.

As a result of restrictions on the creation of new posts, the plant identification service, which is severely understaffed, works under great stress. In order to restrict the service to essential operations it was decided to introduce a handling charge for identifications which will be implemented as from April 1989.

Research has continued, with a few exceptions, at a steady pace. All four journals published by the Institute appeared on schedule. Some significant volumes have appeared in the *Memoirs of the Botanical Survey of South Africa* series. Number 55, *Barrier Plants of Southern Africa*, summarises our knowledge of plants that are suitable for use as hedges or as planted barriers to human and animal incursions, a topical subject in these security-conscious times. The second part of edition two of the *List of Species of Southern African Plants* appeared as Number 56. The significance and usefulness of these catalogues is not sufficiently realised. This work lists the approximately 24 000 taxa, and the synonyms applied to them in the last 50 years, of the flowering plants and the mosses and ferns. The existence of this type of publication, at least on this scale, is unique to southern Africa. The magnitude of the task accomplished is evident only when it is contrasted with the situation in other parts of the world. It is equivalent to the listing of all the plants in Europe, including the Balkans, or of the North American continent excluding Mexico, or of the whole of the Australian continent. The fact that computer-produced lists of names of new species and records and name changes appear annually for use by those interested in plants is yet another unique feature.

The Institute can look back on a very productive year and it contributes significantly to the botanical knowledge essential for maintaining a viable environment.

Plant taxa

Flora of Southern Africa - One fascicle and one ancillary volume were published: Bryophyta, part 1, fascicle 2, by Dr R.E. Magill of the Missouri Botanical Garden, U.S.A., covering 94 species and 32 genera in the 10 families Gigaspermaceae to Bartramiaceae, and the above-mentioned *List of*

Species of Southern African Plants, Edn 2, Part 2, by staff of the Botanical Research Institute. One fascicle is in press, Fabaceae, *Aspalathus*, by the late Prof. R. Dahlgren of the University of Copenhagen, Denmark, and several manuscripts are with the Editor. A number of genera in the Bryophyta, Poaceae, Liliaceae, Orchidaceae, Salicaceae, Mesembryanthemaceae, Fabaceae, Lythraceae, Ericaceae, Convolvulaceae, Pedaliaceae, Gesneriaceae and Acanthaceae were completed and will be published when the rest of their respective fascicles are ready.

Palaeoflora of Southern Africa - The second volume in the Molteno Formation series covering all gymnosperms (except *Dicroidium*) is in the final stages of preparation. New methods of sampling, taxonomy and data presentation have led to new insights about speciation processes, diversity trends and phytogeographic patterns in the ancient continent of Gondwanaland.

PRECIS computerised information system - PRECIS provided botanical information for over 90 research projects during the year. The Specimen component of PRECIS has been increased to hold label information for 643 000 specimens. The Taxon component of PRECIS provided the data for the *List of Species of Southern African Plants* and for an index to the 2 000 colour plates in Volumes 1-49 of *The Flowering Plants of Africa*. This Taxon-PRECIS is now being expanded to include the distribution of each taxon and also life form, distinguishing characters, flowering phenology and importance to man. Prototypes with this information are being constructed for the grass and legume families.

South African liaison officer, Royal Botanic Gardens, Kew, U.K. - The liaison officer provided taxonomic information for 174 researchers and research projects both within and outside the Botanical Research Institute. He attended 31 seminars and 15 meetings. He represented the Botanical Research Institute at meetings of the International Taxonomic Databases Working Group and of the International Legume Database.

Comparative grass leaf anatomy - Intensive field and laboratory studies were undertaken on the genus *Pentaschistis*, during which 52 different species, including 17 new, undescribed species, were collected. All but three *Pentaschistis* species have already been collected. Preliminary results indicate that the genus *Pentaschistis* overlaps with *Merxmuellera*, *Pentameris* and *Pseudopentameris*. These genera are therefore artificially separated and a redelimitation of the genera is essential to reflect natural affinities.

Cytogenetics of grasses - The subgenus *Arundinoideae* has four different basic chromosome numbers, namely 6, 7, 11 and 13. In the *Pentaschistis*-*Merxmuellera*-*Pentameris*-*Pseudopentameris* group the basic numbers 6, 7 and 13 occur

within a genus. This fact supports the anatomical evidence that the genera are artificially delimited at present and that a biosystematic investigation should indicate the generic boundaries. The study further shows that hybridisation occurs on a large scale in these groups and that B-chromosomes play a role during meiosis in these plants.

Cytotaxonomy of grasses - Abnormal meioses and a pollen tube that is too thin cause *Digitaria eriantha* to have a very low pollen fertility and fertilisation number and also very poor seed viability. Since these characters are controlled by genetic factors, there is no agricultural solution to the problem. Only by making new selections will it be possible to obtain a better seed-set and higher viability in this important pasture grass.

Vegetation

Transvaal bushveld and forest studies - Research on the vegetation ecology of the Sour Bushveld of the Waterberg area of the Central Transvaal continues to make progress. Fifty stands representing 10 different vegetation types have been sampled. A new method for determining species cover with greater precision than the usual scale-estimation methods was developed.

The Sabie transect has been extended into the Montane and Subalpine Belts of the Eastern Transvaal Escarpment. Floristic analysis of these additional data yielded 11 new communities distributed between forest (three communities), woodland (three communities), shrubland (two communities) and grassland (three communities). A series of papers is being finalised for publication.

Coastal studies - The vegetation study of the Zululand coastal dunes between Richards Bay and Mlalazi Lagoon was terminated after the main results were published. Twelve 1:20 000 vegetation maps of the dune area between Kosi Bay and Sodwana were produced from aerial photographs. They are currently being used for the drawing of conservation priority maps. Vegetation monitoring on dunes continued (Fig. 1).

Research has been initiated into the salt marshes of four western Cape estuarine systems to obtain a better understanding of their dynamics and environmental relationships. Variations in salinity and water depth were measured from March to September, soils were sampled in September and vegetation was sampled on a bi-monthly basis between March and November. Preliminary indications are that inundation period, inundation regularity and salinity are important factors in determining vegetation patterns.

Cape fynbos studies - Research on the mountain fynbos in the Cedarberg is making good progress. The preliminary check list of the Cedarberg flora, completed during the year, totals nearly 1 400 taxa. The list is being updated by further collections and from literature. The special study in the Welbedacht area, required by the management prior to an experimental burn, was completed by the addition of 17 relevés to last year's data base.

Another 40 relevés have rounded off the northern sector and analysis of the data has begun.

Publications on the vegetation, environment and flora of the Swartboschkloof, Jonkershoek, near Stellenbosch have been finalised. Good progress is being made with studies of the fynbos and other vegetation in the mountain catchments of the Langeberg in the south-western Cape. The field work on the Boosmansbos transect is nearing completion and field data will be synthesised and compared with the results from the first transect.

Grassland studies - The field work for the survey of the vegetation in the Amersfoort area of the Eastern Transvaal Highveld has been completed. All field data have been loaded on to the mainframe computer and production of the final classification table is nearing completion.

Karoo studies - A reconnaissance study of the karoo and other vegetation in the Graaff-Reinet and Middelburg areas of the eastern Karoo Region is well advanced. A hierarchical classification of the vegetation has been prepared, a study of the soil gradient which corresponds to this classification has also been undertaken and both are being prepared for publication.

Central technical support services - Bibliographic references from 1976 to 1986 have been loaded on to the mainframe computer. The second ecological literature data base is now operational and literature searches can be undertaken.

Further progress has been made on the ecological data bank. Forty-seven literature data sets, consisting of theses, publications, reports and field data sets, have been obtained. From these sources the data have been compiled for the phytosociological data base. Thirty-five matrix data sets have been loaded on to the computer, of which 24 sets have appeared in published versions and 11 sets are awaiting classification.

Fynbos reproductive ecology - It has been found that densities of seedlings in the first year of coastal fynbos vegetation recovery following a late spring fire were considerably higher than those of resprouting plants. In shaded conditions and in close proximity to burnt alien *Acacia saligna* (Port Jackson), densities of fynbos seedlings decreased, whereas the proportion of resprouting plants increased.

Fynbos - alien invasive plant interactions - It has been established that plant populations of the calcareous substrates of the West Coast Strandveld, South Coast Strandveld and Limestone Fynbos react in different ways to introduced *Acacia cyclops* (Rooikrans). The largest proportion of positively affected species were annuals (including alien species such as *Lolium temulentum*) on the more arid consolidated sands in Strandveld. The highest proportion of negative species response occurred within typical Limestone Fynbos and included species such as *Protea obtusifolia* and *Adenandra obtusata*.

Fynbos transformation studies - Physical disturbance of mountain fynbos by rotavation can reduce both floristic and micro-environmental

variability during the first two-and-a-half years of recovery. The increase in productivity of two introduced *Protea* species on the disturbed ground, relative to the undisturbed control, was not significant.

A preliminary computer model has been constructed which simulates the utilisation of fynbos veld by a wildflower harvesting business.

Functional ecological studies in Karoo - Evidence from plant-water relation responses suggests that the two most important structural characteristics that determine the success of non-succulent shrubby plant forms in the winter rainfall Karoo relate to their root/shoot ratio and rooting habit. These probably determine seasonal patterns of plant-water stress and, at least, the potential for plant growth, flowering and seed-set.

A computer database of important plant species population responses in the Karoo has been initiated using both formal and the largely untapped informal, undocumented information. Special attention is given to plant responses to major events including episodic rainfall, drought, mass defoliation and selective defoliation incidents.

Valuable veld plants

Conservation of germ plasm - Sixty seed samples of primitive crops were collected and 722 samples of previously collected material were split for distribution to institutions such as the Summer Grain Centre. Seed of food plants from the veld was sent to a number of development agencies locally and overseas. The botanical garden remains a reservoir of material of plants that have become rare or endangered in the veld. Propagative material of 135 indigenous species was made available to nurserymen, to encourage their use and further propagation.

Indigenous food plants - A further eight species were added to the National Food Plant Data Bank, bringing the total of species included to 1617. Information was also added to the records of 617 species already listed.

Manuscripts, for illustrated brochures, on nine of the 14 priority food plants of the veld that are being studied have been prepared. They are *Cucumis metuliferus*, *C. kalahariensis*, *Acanthosicyos horridus*, *Coccinea rehmanii*, *C. sessilifolia*, *C. adoensis*, *Bauhinia petersiana* and *Guibourtia coleosperma*. Seed was made available to researchers.

Primitive crop plants of African origin - Field work was completed in a survey of KwaNdebele during which 60 collections were made and 25 crop frequency/preference questionnaires completed. Analysis of all previously collected material (2266 samples) of *Sorghum* and *Pennisetum* has been completed. The next stage of the work involves computer analysis of the data.

Barrier plants - *Barrier Plants of Southern Africa* appeared as No. 55 in the *Memoirs of the Botanical Survey of South Africa* series. It includes suggestions for indigenous hedging and shelter belt

plants to replace often used alien species - some of which have become invasive.

Woody invaders - The popular version of a survey of woody plant invaders of the Transvaal was published. A chapter on invaders of the fynbos was prepared for a publication on invaders of Mediterranean-type ecosystems of the world. A paper was presented on problems caused by the invasive alien *Solanum mauritianum*.

Catalogue of problem plants - This catalogue, which appeared last year, has sold well and is being widely used by agricultural and conservation personnel. More information about listed and additional species is being catalogued for possible future editions. The catalogue and file material have proved invaluable in providing background information on plants put forward for classification as declared weeds or invaders.

Declared weeds and invader plants - A bulletin on plants already declared weeds or invaders (alien species only) under Act 43 of 1983 was published.

Collections

Herbarium services - Plant identifications numbering 25 858 specimens were undertaken for officers of the Botanical Research Institute, various Government departments, provincial administrations, universities and neighbouring states. Applications have been developed on the Herbarium's multi-user computer system to record and manage all records involving plant identifications, specimen loans and exchanges and to maintain an up-to-date list of plant names. These applications have been operational since July 1987 and in the nine months to date have greatly improved the efficiency of these services.

Expansion of collections - Special collecting expeditions were undertaken to areas poorly represented in the National Herbarium. These included parts of the Richtersveld, Namaqualand, the northern Orange Free State and the central Karoo.

Pretoria National Botanical Garden - Good progress was made with expanding the scientific collections and with providing public amenities. New accessions, mainly from the Fynbos and Succulent Karoo, numbered 599, were obtained. Special habitat conditions were improved with the renovation of several glasshouses. Successful germination experiments were carried out on several indigenous species that have proved difficult to cultivate.

Publications

The following works were published during the year: *Bothalia* 17, 1 and 2; *The Flowering Plants of Africa* 49,3 and 4; *Flora of Southern Africa* Bryophyta 1,2; *Memoirs of the Botanical Survey of South Africa* Nos. 55, and 56. A total of 90 papers were published by Institute staff.

GRAZING RESEARCH

Research Centre for Grazing

The 1984 White Paper on Agricultural Policy strongly emphasised the optimum utilisation of resources as an overall objective in the development of the agricultural industry. As a result of the tremendous decline in natural grazing the National Grazing Strategy was announced in May 1985. Furthermore, the decision was taken to set up a research centre for grazing which will be expanded into a fully-fledged institute over a period of four years. This centre started functioning during the year under review.

It is the function of the Centre to investigate factors which influence the effectiveness of pasture plants, in order to provide information as a basis for effective utilisation practices.

The functions of the Centre may be summed up briefly as follows:

- The collection, introduction and evaluation and the breeding and selection of pasture crops and forage crops.
- The gathering of relevant information on optimum cultivation and utilisation practices and information on the factors which influence production in forage plants.
- Relevant research relating to diseases, pests and weed control.

The research programme is operated in such a way that once a problem has been identified it is dealt with jointly by a team. For functional reasons the research staff are at present divided into five groups, i.e. plant introduction, plant cultivation and plant utilisation, plant breeding and improvement, anatomy and morphology, physiology, management, and utilisation of natural pasture plants by wild animals.

The Centre is situated at the Roodeplaat Research Station near Pretoria. The experimental farms in the various agricultural regions are also used.

Highveld Region

Land conversion scheme - Since the marginal lands at the experimental farm at Potchefstroom were converted into cultivated pasture more than 10 years ago, positive recommendations can be made in respect of the Land Conversion Scheme.

The emphasis on the characteristic of palatability in grasses rather than yield has meant that the period of critical forage shortage from August to October could be overcome at a low cost with Smuts finger grass as standing hay. The animals graze on the grass rather than the grass being cut and, as a result of the recycling of plant nutrients (manure and urine), fertilisation can also be drastically decreased or even completely eliminated. Smuts finger grass is inherently palatable and its

acceptability to animals is therefore not dependent on fertilisation.

Pearce lucerne - S.A. Mutton Merino and Merino weaners are being kept in Pearce lucerne pasture for the second season. The mass increases were very satisfactory and the fact that there were no cases of frothy bloat particularly in the case of the S.A. Mutton Merino is highly significant.

Palatable grasses - In a comparison of grasses that can be established on the marginal maize lands, *Panicum maximum* consistently yielded the highest production compared with Smuts finger grass and wool grass. Westleigh soil gave the highest yield of the three marginal soils that were used.

Lucerne - An investigation into lucerne pasture shows that utilisation in the full bloom stage not only contributes to the prevention of frothy bloat, but also promotes growth vigour and therefore also the life-span of the lucerne.

Natal Region

Veld - It has been found that the species composition of sourveld significantly affects the pattern of selection of species by grazing animal. Season and the length of stay in a camp have a strong influence on species selection and the degree of defoliation. Other factors also play a role.

Veld burning trials have emphasised the need to burn veld at the correct time - preferably just before the first spring rains - and the need to provide an adequate rest following the burn.

Cultivated pastures - Compared with autumn planted Italian ryegrass, spring planted Italian ryegrass has much reduced autumn and winter yields. Spring planted ryegrass is therefore recommended only for specific situations.

Seed yield trials with Midmar Italian ryegrass have indicated the importance of harvesting timeously. As much as half the seed crop may be lost by a delay in harvesting of 7 to 10 days.

It has been noted that nitrate toxicity on highly fertilised cultivated pastures is far less prevalent than was originally suspected. Toxic levels of nitrate in Italian ryegrass and kikuyu were not encountered at the recommended levels of fertilisation.

Nitrate toxicity levels in Italian ryegrass were only encountered at around 1 000 kg N/ha/season and then only during April and September. However, there is a possibility of nitrate poisoning occurring when starved or hungry animals are put onto a highly fertilised pasture.

Pasture nutrition - Field trials, located at both the Cedara and the Ntabamhlope Research Station, have demonstrated the importance of sound soil ameliorative practices in ensuring successful pasture establishment and long-term productivity. The need for an adequate phosphorus supply during the establishment phase of growth has been demonstrated in numerous trials.

The limited persistence of white clover in Natal pastures, referred to as the "two-year clover syndrome", has long been a source of concern to pastoral farmers. Field trials, however, point to a

critical role of lime. Data indicate a close relationship between clover survival five years after establishment and soil pH.

Eastern Cape Region

Valley bushveld - The research programme on this veld type is aimed at estimating the carrying capacity and developing a technique to monitor the vegetation. Preliminary results show that the carrying capacity of the vegetation is low and that the woody component of the vegetation is the most reliable source of forage. The productivity of the grass component of the vegetation is erratic.

Bush-grass communities - Results show that *A. karroo*-plants are able to make opportunistic growth at any time, to take advantage of favourable environmental conditions. Defoliation by goats stimulates growth. Maximum stimulation during the growing season follows defoliation of 50 to 75%. Defoliation intensities of 25% result in maximum stimulation in early spring. A simulation model predicts that increasing the number of camps per flock and sparing or very light use early in the growing season would give large increases in animal production.

Dohne sourveld - According to research in the Dohne sourveld, it seems that heavy stocking pays financially in the short term. This is in contrast to the findings in sweet grassveld, where it does not pay to overstock. Long-term effects still have to be assessed.

Cultivated pastures - In fertiliser trials Coast Cross II responds well to fertiliser in the coastal areas, but Rhodes grass responds little and is therefore suited to low-fertility situations.

In the Dohne sourveld the productivity of *Eragrostis* seems to be restricted by low levels of potassium where it is established on old lands. It also responds well to nitrogen.

In the coastal areas dairy cows grazing kikuyu showed that a rapid rotation allows higher stocking rates and results in higher milk production per ha. The optimum stocking rate of Coast Cross II seems to be around two animal units/ha. At this rate more than 400 kg live mass of beef/ha can be produced.

Transvaal Region

A study with Boer goats is being conducted at the Messina experimental farm in the Mopane veld of the Northern Transvaal to determine their preferences with regard to the edible parts of the wide variety of plant species (trees, shrubs, herbs and grasses). Preceding rest and good rains created favourable grazing conditions and the Boer goats could at will search out and graze on the species they preferred most.

More than 120 plant species were identified by the trial animals as part of their diet. More than 55% of these are herbs, approximately 40% are tree and shrub species and approximately 5% are grasses. However, the goats showed the greatest preference

for 11 tree and shrub species and eight herb species. *Terminalia prunioides* was by far the most sought after tree species, while *Ptycholobium contortum* (a perennial legume) and *Melhania rehmannii* (a perennial non-legume) were the most sought after herbs.

Panicum maximum was the most popular species of grass, but its intake made up only 0,9% of the total intake.

With regard to the utilisation of the veld the Boer goat can in no way be seen to be competing with cattle in conditions where tree, shrub and herb species are found in abundance.

Free State Region

Veld - Three long-term stocking trials are being carried out with cattle at Armoedsvlakte, with sheep at Koopmansfontein and with cattle and sheep at Glen. With the help of these trials a long-term pasture capacity of 7 ha/LSU was laid down for the Armoedsvlakte area.

Both the risk and the detrimental effect on the condition of the veld of a rate that is too high were demonstrated at all three localities. The advantages of higher production per animal at lighter stocking levels were clearly shown in all three trials.

Termite research - Research over the past few years has shown that relatively little success has been achieved with the combating of grass carrier termites using the registered bait insecticides. It seems that only a few of the workers from the various nests are killed. And it would appear that the termites become aware of the danger of the bait insecticide before it is fed to the queen or to the larvae. As a result, the size of a nest decreases only temporarily. The nest is not destroyed by the application of bait insecticide.

Drought characterisation - During the year under review the average monthly veld production for the Glen area of the past 50 years was successfully simulated. According to this the risk of reliable veld production in the early summer could be proved.

Cultivated pasture - Research in the Free State Region showed that *Cenchrus ciliaris* is economically justified as cultivated pasture only if the cattle are rounded off on it. Even at minimum fertilisation levels *C. ciliaris* is not economically justified as cultivated pasture with a weaner production system.

The profitability of the rounding off of cattle on *C. ciliaris* pasture is closely linked with the stocking rate which applies. Care should be taken that maximum voluntary consumption of the pasture is possible at all times. With the correct stocking up to R130/ha gross margin can be achieved, as against R91/ha with maize and only R10/ha with weaner production.

Winter Rainfall Region

In an investigation into the generally poor re-establishment of medic pastures, particularly in the Swartland subregion, it was found that the seed



Dune vegetation in the Mlalazi Nature Reserve on the north coast of Natal. The vegetation of this area is being studied by the Vegetation Ecology Division of the Botanical Research Institute. The photograph shows very clearly the debris zone resulting from the September 1987 floods, followed by the dune ridge generated by colonisation of the debris deposited by the Demoina floods in 1984



Young visitors to the Pretoria National Botanical Garden walking along the nature trail running from east to west along the ridge which bisects the Garden

reserves ranged from as little as 2 kg/ha to as much as 900 kg/ha. The accepted minimum seed reserve for successful re-establishment is approximately 200 kg/ha. Many of the farms therefore do not have adequate seed reserves.

With regard to the influence of cultivation practices, it was found that a shallow tine cultivation had the result that 65% of the seed was concentrated at the most effective depth of 0 to 50 mm. In contrast with this, deeper tine cultivation and deep ploughing resulted in most of the seed being buried too deep for successful re-establishment.

The studies brought to light a number of

possible reasons for the lack of success with medic pastures under certain conditions.

Using the information from plot trials as a basis, climate production models were developed for 11 of the most important cultivated pasture crops in the Winter Rainfall Region. These models can be used to estimate the seasonal production of the crops under both dryland conditions and irrigation.

In research on natural veld, candidate crops are collected and evaluated for re-establishment in the veld. A number of promising legume plants have already been identified.

AGRICULTURAL FINANCE

Agricultural Credit Board

The activities of the Directorate of Financial Assistance are determined largely by the Agricultural Credit Board. During the year under review the Board dealt with 12 056 cases, as against 13 052 the previous year.

Granting of assistance

During the year under review it was still not possible to accede to all requests for financial assistance of the kind granted to farmers by the Agricultural

Credit Board. Schemes that remain suspended were those for the purchase of implements, waterworks, and the sinking of boreholes, the eradication of invader bush, afforestation, the effecting of improvements and the purchase of land.

Approval was given for the Agricultural Credit Board to include in the debt consolidation schemes farmers' debts incurred before 1 August 1987 in respect of these schemes.

There have not been as many applications for settlement proposals under the R400 million scheme as were expected. The Agricultural Credit Board considered only 356 applications during the year under review and assistance of one kind or another was given to 123 applicants amounting to a total sum of R21 116 470.

The amounts granted by the Agricultural Credit Board during the year, and the number of loans and the number of rejected cases, are shown in Table 1 opposite each scheme.

The reasons for the discrepancy between actual expenditure and the amounts granted by the Board are the following:

- A considerable number of applications that had been approved by the Board had not yet been settled by 31 March 1988 and some payments were in respect of grants made by the Board during the previous year.
- Between 50% and 80% of the grants made by the Board for disaster aid represent a subsidy and do not form part of a loan.
- There were savings on or cancellations of assistance.

Granting of assistance in Designated Areas

Northern and North-Western Transvaal and Northern and North-Western Cape Border area

Although there were good rains over practically the entire area during the year under review, farmers are still suffering from the effects of the prolonged drought over the past few years and continuing unfavourable economic conditions. As a result of this a large section of the farming community in the Designated Areas relies on the State for special help.

In order to meet the needs of the farming community, a total amount of R41 215 053 was paid out during the year under review under the various assistance schemes. These assistance measures are aimed at the stabilisation of agriculture and of the security situation in the area.

All the assistance schemes are made available with very favourable repayment conditions and low interest rates.

TABLE 1

Scheme	1987/88		Number of applications rejected
	Number of loans	Granted Amount R	
Purchase of means of crop production (seed, fertiliser, fuel, etc.)	2 939	129 934 053	445
Purchase of livestock	13	717 000	73
Purchase of farm implements equipment	3	201 700	-
Construction of soil conservation works	53	1 745 202	2
Building of water-works	4	347 333	3
Drilling	8	25 331	-
Control of bush encroachment	-	-	-
Purchase of agricultural land and grants of land	307	32 073 232	189
Making or repair of improvements	-	-	1
Installation of a power line and electrical distribution network	-	-	-
Establishment and/or management of a private forest	-	-	-
Payment of farming debts, including mortgage debts	1 158	114 080 720	1 249
Housing for farm labourers	694	19 198 526	26
Disaster aid			
Stock feed scheme in scheduled grazing distress areas, including the transportation of drinking water for livestock	321*	22 655 040**	15
Flood relief scheme Natal flood, September 1987	25	1 773 529	2
Total	5 525	322 751 666***	2 005

*Only new applications received

**Subsidies included

***Amount actually spent on loans, about R216 million

TABLE 2

Financial year and scheme	Number	Applications considered		Number	Loans granted	
		Amount	Average		Amount	Average
		R	R		R	R
1984/85	3 055	121 691 794	39 834	2 661	87 552 282	32 902
1985/86	3 217	133 328 167	41 445	2 651	96 115 891	36 256
1986/87	3 127	141 169 408	45 145	2 741	111 778 793	40 780
1987/88	3 384	170 409 379	50 357	2 939	129 934 053	44 210

State land

During the year under review 21 155 hectares of agricultural land, to the value of R5 047 850, was awarded to successful applicants. In the previous year 50 100 hectares was awarded. The reason for the significant decrease is that during the 1987/88 year here reviewed State land was not made available under agricultural schemes on a large scale.

Short-term assistance

Crop production loans are of a continuous nature and may be granted in all the recognised field cropping areas of the country. Loans of up to a

maximum amount of R50 000 per calendar year are available for this purpose at present.

As a result of the severe drought of the past few years approval was granted for the production loans in the summer rainfall field cropping areas, as in the previous year, to be increased to R75 000 and for this concession to be provisionally extended for a further year to 31 August 1988. This date also applies in respect of the interest subsidy of 4% on such loans and the concession that where necessary production loans may be partly used for the payment of wages and maize meal rations for farm labourers.

Particulars in connection with applications for loans of this kind considered by the Board during the past three financial years are given in Table 2.

TABLE 3

Financial year and scheme	Number	Applications considered		Number	Loans granted	
		Amount	Average		Amount	Average
		R	R		R	R
Land purchases						
1984/85	85	20 810 165	244 825	19	3 740 125	196 849
1985/86	101	35 924 841	355 691	22	4 761 300	216 423
1986/87	156	51 176 757	328 056	58	10 409 087	179 467
1987/88	326	100 816 576	309 252	137	29 497 443	215 310
Improvements						
1984/85	34	1 178 707	34 668	19	525 978	27 683
1985/86	1	60 000	60 000	1	50 000	50 000
1986/87	6	2 318 432	386 432	2	100 000	50 000
1987/88	1	27 000	27 000	-	-	-
Discharge of debts						
1984/85	1 658	262 173 560	158 126	787	46 576 115	59 182
1985/86	2 233	460 092 960	206 043	834	56 493 929	67 739
1986/87	2 298	523 702 119	227 895	827	60 561 377	73 230
1987/88	2 407	578 214 302	240 221	1 158	114 080 720	98 514
Soil conservation works						
1984/85	55	1 338 439	24 335	55	1 306 000	23 745
1985/86	65	1 690 523	26 008	64	1 565 224	24 457
1986/87	69	1 616 339	23 425	67	1 593 552	23 784
1987/88	55	1 893 549	34 428	53	1 745 202	32 928
Waterworks						
1984/85	127	8 051 521	63 398	88	5 064 713	57 554
1985/86	3	173 000	57 667	1	29 100	29 100
1986/87	10	434 425	43 442	2	53 383	36 692
1987/88	7	641 293	91 613	4	347 333	86 833
Housing for farm labourers						
1984/85	141	2 285 516	16 209	135	2 160 841	16 006
1985/86	2	17 000	8 500	2	17 000	8 500
1986/87	516	11 749 060	22 769	488	10 955 660	22 450
1987/88	720	19 669 762	27 319	694	19 198 526	27 663
Livestock						
1984/85	79	3 242 950	41 050	26	439 671	16 910
1985/86	34	1 760 400	51 776	27	549 625	20 356
1986/87	87	4 213 060	48 426	19	526 700	27 721
1987/88	86	4 526 450	52 633	13	717 000	55 154
Implements						
1984/85	20	741 125	37 056	4	93 830	23 457
1985/86	None	-	-	None	-	-
1986/87	5	153 705	30 741	2	62 700	31 350
1987/88	3	201 700	67 233	3	201 700	67 233

Long-term assistance

Table 3 gives particulars of applications considered by the Board during the past three years.

Emergency assistance schemes

Drought assistance schemes

Although widespread rains again fell throughout the country during the year under review, there was still drought in large parts of the country. Drought assistance was therefore considered for livestock farmers in terms of the Livestock Grazing, Field Husbandry and Phased Schemes - the Livestock Grazing Scheme was by far the largest scheme.

Table 4 contains particulars of the number of districts by province with the assistance applicable on 31 March 1988 as against the same date in the previous year. Table 5 contains the expenditure under the various schemes compared with the figures for the previous year.

TABLE 4

Province	Date	Stock Grazing Scheme	Field Husbandry Scheme	Phased Scheme
Cape Province	31/3/1987	31	2	3
Orange Free State		3	5	0
Transvaal		4	3	0
		38	10	3
Cape Province	31/3/1988	25	3	2
Orange Free State		6	1	0
Transvaal		7	3	0
		38	7	2

TABLE 5

1986/87				
Schemes	Rebates	Loans	Subsidies	Incentives
Total	R5 000 000	R5 273 575	R27 500 303	R12 589 595
1987/88				
Schemes	Rebates	Loans	Subsidies	Incentives
Total	R5 490 456	R7 999 598	R44 653 171	R24 597 337

Subsidisation of interest on carry-over debts, new production credit and the 2+20 year debt consolidation scheme

The special drought relief scheme for carry-over debts in the summer rainfall field cropping areas, which includes a six-year and a ten-year-scheme, remains in force as in the previous year.

Additional assistance was introduced as from 1 May 1987 in the form of further interest subsidies as follows:

- In respect of the six-year scheme the carry-over debts are subsidised by 6,5 percentage points,

based on the Land Bank's lending rates, for two years from 1 May 1987 (winter crops) and 1 September 1987 (summer crops) and subsequently by 5,5 percentage points for a further two years, and

- in respect of the ten-year scheme further subsidies are to be paid and these will come into effect on 1 May 1989 (winter crops) and 1 September 1989 (summer crops), respectively.

A debt carry-over scheme for livestock farmers in co-operatives was established as from 1 April 1987 for a period of three years in the extensive livestock grazing areas where the drought assistance schemes applied or still exist. Under this scheme the interest rates on such debts with co-operatives are subsidised by the State during the first two years by an amount equal to 6,5% per annum of the Land Bank's lending rate on cash credit accounts to agricultural co-operatives and during the third year by 5,5% per annum.

An interest subsidy equal to 35% of the Land Bank's lending rate, based on cash credit loans to agricultural co-operatives, is paid to farmers in the drought-stricken summer rainfall field cropping areas where their carry-over debts to agricultural co-operatives, as at 31 August 1987, exceed their input costs for 1986/87 in respect of their production credit facilities for the 1987/88 season.

The 2+20 year debt consolidation scheme is a Land Bank scheme under which the urgent debts of farmers are taken over at Land Bank interest rates. Interest for the first two years is capitalised and the first payment is made at the end of the third year. The Land Bank's interest rate is subsidised by the State by 7,5 percentage points per annum, which represents the equivalent of 4%. The maximum amount per loan per farmer on which the subsidy may be paid may not exceed R750 000.

Further subsidies at other rates and over other periods are also payable to sugar cane, table grape and deciduous fruit producers.

During the year under review a total of R150 719 757 was paid to the Land Bank, as against R120 475 679 the previous year. Furthermore, during this period an amount of R12 578 688 was paid to the Land Bank in terms of the State's guarantees in respect of losses suffered under these schemes.

Flood damage

As a result of the flood disaster in Natal during September/October 1987 the whole of Natal was declared a flood-stricken area and the following assistance measures were introduced:

Item 1

A 100% subsidy for land which was totally washed away or the rehabilitation of which is not desirable.

Item 2

A loan with a 75% subsidy or only a subsidy of 75% is available for the rehabilitation of land, the

replanting of crops and the recovery of infrastructure, waterworks and soil conservation works.

Item 3

A subsidy of 75% for farmers whose net farming income does not exceed R7 500,00 per annum.

The following amounts were paid during 1987/88 in respect of these items:

Item 1:	R1 408 673
Item 2:	R5 447
Item 3:	R8 238
	R1 422 358

Water quota subsidies

This assistance scheme was introduced to enable farmers to remain on their farms until sufficient irrigation water (50% of the water quota) becomes available so that they can continue production. The various schemes and the amounts paid are set out in Table 6.

TABLE 6

Irrigation schemes	1986/87	1987/88
Riet River	1 823 646	1 158 581
Kaffer River	208 456	122 454
Lindleyspoort	279 869	202 914
Olifantsnek	148 368	419 059
Koster River	-	101 430
Klipdrift	-	157 375
Rust-de-Winter	363 973	218 695
Crocodile River	525 156	6 900
	3 349 468	2 387 408

Change from marginal ploughed land to lands under perennial pasture crops

This scheme came into operation on 1 October 1987 and is aimed at converting lands which were under cash crop cultivation in the 1986/87 summer season and which are not suitable or are less suitable for cash crop cultivation, into land under perennial pasture crops. Although priority was initially given to the recognised dryland summer rainfall field cropping areas, the scheme was expanded to other parts of the country.

After the successful establishment of a perennial pasture crop a subsidy of R80 per hectare for establishment and R50 per hectare compensation in respect of the loss of income on cash crop cultivation is paid for four years. A minimum of 10 hectares and a maximum of 150 hectares per farming unit will be a guideline. The established pasture crop must be maintained for eight years. Payments started in January 1988 and in the last three months of the year under review amounted to R597 815.

Interest subsidy on the production credit of farmers at mercantile banks in the drought-stricken summer rainfall cropping areas

This scheme applies from 1 May 1987 to 30 April 1988 in respect of winter crops and from 1 September

1987 to 31 August 1988 in respect of summer crops and claims are submitted every six months (on 31 May and 30 November) by the mercantile banks.

The interest subsidy is calculated at 35% of the average interest rate of the Land Bank for cash credit accounts for the relevant term. The maximum amount at which interest subsidy is payable is R250 000 per farming unit per season.

All production means and services as defined in sections 172 and 173 of the Co-operation Act, 1981 (Act 91 of 1981), will qualify for the scheme, with the exception of the purchase sum of livestock and all production means for the establishment of vineyards, orchards and sugar cane.

Conveyancing

Registration of mortgages and documents of consent and issuing of deeds of grant

During the year under review 2 260 mortgages were registered, as against 1 309 in the previous year. There was also a considerable increase in the number of documents which were registered, namely 6 889 as against 2 670 in the previous year. This increase is due to the greater number of mortgages and documents of consent and the number of cases where the Department had to waive the priority of its mortgages in favour of the Land and Agricultural Bank of South Africa, namely 935 as against only 261 in the previous year.

Legal actions

During the year under review the legal action section was established and was instructed to deal with certain legal actions.

Continuing unfavourable economic conditions and the results of the prolonged drought during the past few years were responsible for a large number of debtors not being able to meet their financial obligations to the Department. There were 19 cases where the Department had to attach properties in order to recoup or partially recoup outstanding mortgage debt.

There have again been various cases where debtors whose estates have been sequestered have before insolvency unlawfully dealt with loose security which belonged to the State. The Department was therefore obliged to act against the persons concerned and in 18 cases charges were laid with the South African Police.

Debtors and securities

Recovery of debts

An amount of approximately R133 million in debt was collected during the year under review. Numerous requests for extension were considered and, in justified cases, approved. Requests for extension for the repayment of crop production

loans were dealt with mainly on an urgent basis during personal interviews as a result of the increasing pressure placed on farmers by private institutions for the payment of debts in arrears.

As regards stock feed loans, numerous requests for extension or consolidation were received. A lenient policy is followed in terms of which farmers are given the opportunity to pay back stock feed loans in three equal annual payments. The total amount owed to the agricultural credit account increased as a result of the continuing drought and

stood at approximately R834 million at the end of this financial year.

Control over securities

To safeguard the State's securities, Departmental agricultural credit controllers carried out 1 095 special and 3 885 routine investigations. Approximately 186 attachments were carried out and eventually led to the liquidation of securities.

AGRICULTURAL PRODUCTION ECONOMICS

Production economics research

The Directorate of Agricultural Production Economics continued with or completed the following projects in the field of the economics of agricultural production:

Production factor studies

- An agricultural economics evaluation of alternative irrigation systems in the Orange-Vaal irrigation area.

Structure studies

- The development of an alternative method for determining minimum farm sizes.
- A study of the cost/benefit analysis for investment decision-making on agricultural development projects by the public sector.
- Market potential and price analysis of selected agricultural products for cost/benefit analysis of resource development.
- Quantification of the relationship between input and output and the expected economic yield for crop production with a variable water supply.
- Economic analysis of irrigation schemes and water provision schemes:
 - Orange-Riet River Canal
 - Vaalharts State Water Scheme
 - Hartbeespoort Irrigation Board Scheme
 - O.R.P. Lower Fish State Water Scheme
 - Lindleyspoort State Water Scheme
 - Palala River
- The financial rehabilitation of crop farmers with liquidity problems in the summer rainfall field cropping areas.
- A systems approach to decision-making analysis in irrigation farming.
- An efficiency comparison of large and small farming enterprises and company and family farming enterprises in the Sundays River Valley, Eastern Cape.

Operating and production cost surveys

Comprehensive operating and cost surveys are undertaken annually on a rotation basis in one of the three chief wheat-producing areas with supplementary surveys in the remaining areas. The production costs for several other branches of farming are also calculated from these surveys, including costs for barley and oats.

A comprehensive production cost survey was undertaken this year for wheat in the Rûens area.

Typical farm models for policy research

There is a great need to get an indication of the possible impact and efficiency of agricultural policy measures at the micro-farm level before they are implemented. The same need exists in respect of the effect of expected changes in macro-economic variables, such as interest rates and exchange rates, on the economic or financial position of farmers. With a view to this a start was made on the development of a few typical farm models for different types of farms.

Farm management techniques

With regard to the development of managerial aids and managerial information systems the following matters received attention during the year under review:

- Further refining and expanding of the computerised income and cost estimate system (COMBUD).
- The design of a computerised financial farm accounting system based on the methods contained in the conventional Financial Record Book for Farmers.
- The development of techniques for the establishment of a farm management assistant service for farmers with the aid of advanced computerised planning techniques.
- The creation and maintenance of norms for implement costs.
- Strategies to maximise the after-tax profit and capital growth of Lowveld avocado farms.
- Research on a marketing strategy for extensive beef production in the Northern Transvaal Bushveld.
- Research on the effect of income tax on the decision-making process of extensive stock farmers in the Free State Region.

Farm business economics with mail-in records as the source data

This is a continuous project which has been in progress for more than 20 years. The numbers of mail-in records collaborators who received analyses of their farms during the year under review (with numbers for the previous year in brackets), are as follows: Collaborators of the Directorate: 539 (527), divided into 82 (81) study groups; collaborators involved through co-operatives whose farming enterprises were analysed by the Directorate: 279 (268), divided into 10 (12) study groups. At present 148 (265) farmers are on the computerised Transakplan I system.

Income and cost estimates

The computerised income and cost estimates system (COMBUD) at present contains 694 estimates. These consist of 629 crop estimates and 65 livestock estimates. Of these, 98 are experimental estimates and 165 temporary estimates and 431 permanent estimates. These estimates were printed out in September 1987 and were distributed individually and in the form of volumes. The implement costs guide, which is published annually, was brought up to date.

Commodity ratios

In co-operation with technical researchers in regions and at institutes the Directorate gave attention to the following research projects relating to commodity ratios (input/output ratios) during the year under review:

- The inclusion of perennial grazing crops in sheep production systems in the Free State grassveld pasture area.
- The economic evaluation of the utilisation of planted pasture in Merino sheep in the Fish River Valley.
- The economic evaluation of the potential of artificial pastures for small stock in the eastern coastal areas of the Eastern Cape Region.
- The development and evaluation of a profitable stock farming system for the Valley Bushveld of the Eastern Cape Region, both in a very poor condition and in a good condition.
- The development, management and evaluation of an adapted stock farming system at Campagna in the high-rainfall sourveld area of the Eastern Cape Region.
- The influence of various feeding strategies on the economic efficiency of small-stock farming in the summer rainfall field cropping areas.
- The influence of various feeding strategies on the economic efficiency of beef cattle farming in the summer rainfall field cropping areas.
- A comparison of profit margins from weaner calf, tollie and ox production systems in the Northern Transvaal Bushveld.
- The economic evaluation of milk and meat production from Simmentaler cattle on natural

veld and dryland *Cenchrus* grazing on the Springbok Flats of the Transvaal.

- The wintering of woolled sheep and other stock in the Northern Drakensberg grazing area.
- An evaluation of the profitability of irrigated artificial pastures for stock farming in the high-rainfall sourveld areas of Natal.
- A few economic aspects of the use of fertiliser for maize production in Natal.
- A long-term economic evaluation of various sheep production systems at various loading limits on climax grass in the Central Free State.
- An economic evaluation of the RHB concept with a view to minimising risk and determining land value.
- An investigation into the underlying reasons why some irrigation boards meet their obligations and others do not.

Training and advice

Although the Directorate's primary task is research, an important contribution in the form of training and advice was once again made.

With regard to training, officers at the Directorate made the following contributions during the year under review in respect of agricultural economics at the five colleges of agriculture (with the figures for the previous year in brackets): 368 (638) formal lectures and 130 (174) practicals were held. The considerable decrease in the number of lectures and practicals is largely as a result of the appointment of agricultural economists as training officers at two of the colleges who are gradually taking over the holding of lectures. During the year under review a start was made on the revision of the series of agricultural economics lectures which are held for juniors at the colleges of agriculture.

By offering short courses, lectures on farmers' days, visits to and from farmers and by answering written and telephone queries, the Directorate renders an extensive advisory service on production economics in agriculture in support of this Department's information service. 56 lectures were, for example, delivered at farmers' days, and 17 fully-fledged short courses were held for farmers during the year under review.

SUPPORTING SERVICES

Biometric and datametric services

As a result of the serious shortage of biometricians, datametricians are expected to provide statistical services. This problem is alleviated to a certain extent by providing both datametricians and researchers with biometric training.

Biometric consultation consists of the evaluation of new trials, the re-planning of existing programmes and the processing and interpretation of results.

The datametric service has a strong data processing component. In addition to this, staff in the service are very involved in the introduction of micro-computers and the application of programme packages. Various new programmes have been developed to promote the interpretation of research results.

The service relating to scientific systems was linked specifically with the development of the communications system at the Vegetable and Ornamental Plant Research Institute, the development of a computerised laboratory system for the foot and mouth disease laboratory at the Veterinary Research Institute and the development of local network systems.

Great interest on the part of research staff in the use of micro-computers, particularly with a view to the preparation of publications, has resulted in considerable attention being devoted to "desk top publishing". Individual instruction in the use of micro-computers is provided on a regular basis.

Research by other institutions

Contract research at universities

Ninety-nine applications were received to have contract research undertaken at universities, and all were approved. The universities of the Orange Free

State, Potchefstroom, Pretoria, Rhodes, Stellenbosch, Witwatersrand, Natal, Cape Town, RAU, Port Elizabeth, Fort Hare, Western Cape and the Medical University of Southern Africa were involved.

Projects were undertaken for the Vegetable and Ornamental Plant Research Institute (4), Citrus and Subtropical Fruit Research Institute (15), Fruit and Fruit Technology Research Institute (4), Viticultural and Oenological Research Institute (1), Plant Protection Research Institute (14), Summer Grain Centre (10), Small Grain Centre (8), Oil and Protein Seeds Centre (4), Tobacco and Cotton Research Institute (1), Botanical Research Institute (3), Soil and Irrigation Research Institute (5), Veterinary Research Institute (10), Animal and Dairy Science Research Institute (1), Transvaal Region (4), Natal Region (3), Winter Rainfall Region (4), Eastern Cape Region (2), Highveld Region (1), Grazing Research Centre (1) and Directorate of Agricultural Engineering (4).

Ad hoc research at universities

Sixty-six applications were received of which 44 were approved. Departments at universities which received research support were Zoology (1), Entomology (2), Animal Science (6), Poultry (1), Human and Animal Physiology (1), Biochemistry (7), Genetics (3), Veterinary Physiology (1), Parasitology (3), Mammal Research Institute (1), Tick Research Unit (1), Pharmacology/Toxicology (1), Contagious Diseases (2), Veterinary Public Health (1), Food Science (1), Chemistry (1), Microbiology/Plant Pathology (5), Soil Science/Plant Production (3), Crop Science (1), Botany (1), Agricultural Engineering (1).

Foreign research fellows at universities

No applications were received.

ORGANISATION AND FUNCTIONS OF THE DEPARTMENT

The Department of Agriculture and Water Supply has the responsibility of promoting optimum agricultural production and the welfare of the farmers in the White population group of the RSA. According to the Constitution the Department is specifically responsible for the following services and assistance measures:

- Agricultural development services, including research, advisory services and extension
- Training at colleges of agriculture
- Financial and other assistance to farmers or prospective farmers or for the promotion of agriculture
- Irrigation schemes
- Drilling for water for agricultural and local authority purposes
- Subsidising of drilling and water affairs for agriculture and local authority purposes
- Financial assistance in respect of water-works damaged by floods.

To accomplish this task the Department consists of an Executive Directorate with the Superintendent-General assisted by an Executive Director and six chief directors who are responsible for the management functions of the Department. At the level of implementation, 24 institutions, each with a Director in charge, are responsible for the specialised functions.

EXECUTIVE DIRECTORATE

Agriculture Building, Beatrix Street,
Private Bag X116, Pretoria 0001

Dr A.J. Heyns: Superintendent-General
Dr F.J. van der Merwe: Executive Director

Chief Directorate

Agronomy

Dr W.P. Grobbelaar: Chief Director
Mr F.I. du Plooy: Senior Agricultural Management Adviser

Horticulture

Dr G.S. Bredell: Chief Director
Dr J.L. van Zyl: Senior Agricultural Management Adviser

Agricultural Engineering and Water Supply

Mr C.T. Crosby: Managing Engineer
Vacant: Senior Agricultural Management Adviser (Irrigation)

Animal Production

Dr R.D. Bigalke: Chief Director
Mr J.A. Erasmus: Senior Agricultural Management Adviser

Farming Development

Mr J.J. Bruwer: Chief Director
Dr A.J. Aucamp: Senior Agricultural Management Adviser (Pastures)
Mr L.M. le Roux: Senior Agricultural Management Adviser (Extension and Training)
Vacant: Senior Agricultural Management Adviser (Natural Resources)
Mr D. Grossman: Senior Agricultural Management Adviser (Game Farming)

Auxiliary Services

Mr H.F. van Zyl: Chief Director

Specialised Research Institutes

Animal and Dairy Science Research Institute
Private Bag X2, Irene 1675

Dr J.H. Hofmeyr: Director
Dr J.C. Oosthuizen: Director
Dr P.E. Lombard: Deputy Director
Dr R.T. Naude: Deputy Director
Dr E.H. Kemm: Deputy Director

The Institute, at various centres throughout the country, undertakes performance and progeny testing at the national level, as well as fundamental research on the breeding, feeding and physiology of farm animals. The Institute is also responsible for dairy and poultry research on a country-wide basis as well as for the training of dairy technologists at Glen.

Botanical Research Institute
Private Bag X101, Pretoria 0001

Dr B. de Winter: Director
Dr D.J.B. Killick: Deputy Director
The Institute undertakes basic research on the

flora and vegetation of South Africa with emphasis on taxonomy, morphology, ecology and economic botany. The Institute also controls the Botanic Garden at Brummeria (Pretoria) and herbaria in Durban, Grahamstown, Kimberley, Pretoria and Stellenbosch.

Citrus and Subtropical Fruit Research Institute
Private Bag X11208, Nelspruit 1200

Dr J.H. Terblanche: Director
Dr A.J. Joubert: Deputy Director

The Institute is responsible for country-wide research on all aspects of the citrus and subtropical fruit industry, as well as nuts, tea, coffee and herbs.

Fruit and Fruit Technology Research Institute
Private Bag X5013, Stellenbosch 7600

Dr P.C. van Rooyen: Director
Dr H.J. van Zyl: Deputy Director

The Institute is responsible for research on deciduous fruit, and certain aspects of proteas as well as for research at national level in connection with certain technological aspects of fruits and other agricultural products. The Institute further renders a radiation and radio-isotope service in connection with agricultural problems in the winter rainfall complex.

Grain Crops Research Institute
Private Bag X1251, Potchefstroom 2520

Dr J.W. Snyman: Director
Dr J. de Kock: Deputy Director (Winter Grain)
Dr K.W. Pakendorf: Deputy Director (Oil and Protein Seeds)
Dr J. Dreyer: Deputy Director (Summer Grain)

The Institute is responsible for research on the improvement and cultivation of summer and winter cereals and high protein seeds and oilseeds.

Plant Protection Research Institute
Agriculture Building, Beatrix Street,
Private Bag X134, Pretoria 0001

Dr I.H. Wiese: Director
Dr D.P. Keetch: Deputy Director
Dr V.D. Wassermann: Deputy Director
Dr B.W. Strydom: Deputy Director

The Institute is mainly responsible for advanced research at the national level on plant pathology, insect and animal pests and their control. This includes microbiology, taxonomy of fungi, identification of virus diseases, the freeing of propagation material from viruses, honey-bees, insects in stored grain, forest and timber insects, taxonomy of insects and nematodes, economic

zoology, toxicology of insecticides and the biological control of insect pests and weeds. The Institute is also responsible for the examination and control of imported plant material and the control of migratory locusts.

Soil and Irrigation Research Institute
600 Belvedere Street, Arcadia. Private Bag X79,
Pretoria 0001

Dr D.M. Scotney: Director
Vacant: Deputy Director
Dr J.F. Eloff: Deputy Director
Dr A.J. van der Merwe: Deputy Director
Mr J.E. Volschenk: Deputy Director

The Institute is responsible for the classification of the resources soil and climate of the Republic as well as basic research to promote the efficient utilisation of soil, water and fertilisers, to identify problems in this regard and to find answers to these problems with a view to the improvement of agricultural production and the protection of the resources soil and water. Soil surveys for irrigation projects and investigations into physical soil properties are also undertaken - particularly where brack and waterlogging conditions occur. In addition, the Institute is responsible for basic irrigation research and the agricultural evaluation and planning of irrigation areas. All agricultural meteorological research and data collection also fall under this Institute and the remote sensing component acts as the specialist centre of the Department. The Institute undertakes the chemical analysis of soil, water and plant material, not only for this Department but also for other State Departments, Provincial Administrations and other bodies. It is also responsible for the inspection and analysis of fertilisers, stockfeeds, stock remedies and agricultural remedies in terms of Act No. 36 of 1947.

Tobacco and Cotton Research Institute
Private Bag X82075, Rustenburg 0300

Dr D.J. Rossouw: Director
Dr G.D. Joubert: Deputy Director

The Institute is responsible for research, including technological research, in the interest of the tobacco industry in all parts of the country.

Vegetable and Ornamental Plant Research Institute
Private Bag X293, Pretoria 0001

Dr J.T. Meynhardt: Director
Dr W.P. Burger: Deputy Director

The Institute is responsible for all applied and fundamental research and specialised extension on vegetables, cut-flowers, ornamental plants and shrubs throughout South Africa. The Institute controls vegetable, flower and ornamental plant research at Rooideplaas in the Transvaal Middleveld and cherry research at Emperani, near Ficksburg.

Veterinary Research Institute
P.O. Onderstepoort, Pretoria 0110

Dr D.W. Verwoerd: Director
Dr J.D. Bezuidenhout: Deputy Director
Vacant: Deputy Director
Dr B.J. Erasmus: Deputy Director
Dr G.R. Thomson: Deputy Director

The Institute is concerned with research on diseases of stock and game (infectious and others, including diseases caused by malnutrition), diagnostics, the preparation of vaccines and diagnostic aids, and the biological evaluation of dips and remedies submitted for registration.

Viticultural and Oenological Research Institute
Private Bag X5026, Stellenbosch 7600

Dr J. Deist: Director
Mr C. Kok: Deputy Director

The Institute is responsible for all research in the sphere of viticulture and oenology, *inter alia*, viticultural research in the Lower Orange River area.

Directorates

Agricultural Economics
Private Bag X416, Pretoria 0001

Mr B.J. van Wyk: Director
Mr G.R. Backeberg: Deputy Director

The Directorate's main task is to research the production economics of agriculture and to make known the research results and general production economics principles.

Agricultural Information
Agriculture Building, Beatrix Street,
Private Bag X144, Pretoria 0001

Dr R.J. van Niekerk: Director
Vacant: Deputy Director
Mr L.L. Lötter: Deputy Director

The function of the Directorate is the distribution of agricultural information by means of the mass media. For this purpose use is made of scientific and popular agricultural publications, radio programmes, audiovisual aids and press releases. The Directorate is also responsible for the maintenance of an agricultural information bureau.

Agricultural Mechanisation
Private Bag X515, Silverton 0127

Mr A.J. Heyns: Chief Engineer
Mr P.A. Henning: Deputy Chief Engineer
Mr P.J. Britz: Deputy Chief Engineer
Mr J. Fuls: Deputy Chief Engineer

As one of the constituents within the Chief Directorate Agricultural Engineering and Water Supply, this Directorate conducts research,

development, test work and technology transfer in the fields of agricultural machinery, mechanisation planning, agricultural structures, farm buildings, animal housing and agricultural energy.

Agricultural Technical Administration
Agriculture Building, Beatrix Street,
Private Bag X116, Pretoria 0001

Mr J.H. Smit: Director
Mr S.O. Joubert: Deputy Director

Administrative support to management. Manages also specific matters regarding foreign study tours, research fellows, foreign visitors, international organisations of which the Department is a member, collaboration agreements in the agricultural field with several countries, multilateral and bilateral liaison with Botswana, Lesotho and Swaziland and the TBVC countries, as well as agricultural projects financed by the Department of Foreign Affairs. In addition the Directorate has various administrative tasks arising from the professional/technical functions of the Department.

Biometrical and Datametrical Services
Agriculture Building, Beatrix Street,
Private Bag X116, Pretoria 0001

Dr J.P. Jooste: Director
Mr J.N. de Bruyn: Deputy Director

The Directorate is responsible for bio- and datametrical services to the Department.

Financial Assistance
Opera-Plaza Building, Bank Lane, Church Square,
Private Bag X118, Pretoria 0001

Mr J. Rademeyer: Director
Mr D. Franken: Deputy Director
Mr C.C. Snyman: Deputy Director
Mr J.H. van Tonder: Deputy Director
Mr D. Henrico: Deputy Director
Mr J.Z. Dorfling: Deputy Director

To provide financial and/or other assistance to deserving farmers and farming enterprises with a view to promoting the agricultural industry by means of loans in terms of various assistance schemes, the sale or leasing of immovable or movable property of the State that is suitable for farming purposes, and the institution of protective measures in the form of the suspension of legal proceedings against farmers pending the possible granting of one or other form of assistance and arranging for farmers to compound with their creditors. The Directorate administers the Agricultural Credit Act (Act 28 of 1966) and the Designated Areas Development Act, 1979 (Act 87 of 1979).

Irrigation Engineering
Private Bag X515, Silverton 0127

Mr F.J.C. Hugo: Chief Engineer
Mr F.B. Reinders: Deputy Chief Engineer
Mr A.A. Louw: Deputy Chief Engineer
Mr A.M. Meyer: Deputy Chief Engineer

Mr J.F. van Staden: Deputy Chief Engineer
Mr D.J. du Rand: Deputy Chief Engineer
Mr K.O. Bang: Deputy Chief Engineer

This Directorate resides within the Chief Directorate Agricultural Engineering and Water Supply and is responsible for research, development, evaluation and technology transfer regarding irrigation equipment and irrigation planning. The Directorate develops irrigation schemes, administers irrigation boards and handles applications for financial assistance in terms of the irrigation subsidy scheme.

Soil Conservation and Drilling Services

Private Bag X515, Silverton 0127

Mr J. Veenstra: Chief Engineer
Mr C.S. Hawkins: Deputy Chief Engineer
Mr P.J. Strumpher: Deputy Chief Engineer
Mr H.W.P.W. Strück: Deputy Chief Engineer

The functions of this Directorate, which resides within the Chief Directorate Agricultural Engineering and Water Supply, entail research, development and special investigations in the field of soil conservation engineering; planning, design and construction of key soil conservation works; provision of engineering advice to soil conservation technicians in the Regions; administration of subsidy schemes for soil conservation, bush control and flood assistance. The Directorate manages the Departmental water drilling service by means of physical drilling and the relevant inspection services through 17 drilling inspectorates. It also administers the drilling subsidy scheme.

Agro-ecological Regions

The seven Regional Organisations of the Department are responsible, within their respective geographical areas, for the planning, development, promotion and application of farming systems based on optimum land use.

Each region provides an extension service in which the soil conservation effort is integrated and which also covers every aspect of farming. The research services are directed to the collation and releasing of scientific knowledge for the optimum use of the natural agricultural resources. The research personnel is also responsible for specialist extension work and for supplying training services to the agricultural colleges.

Eastern Cape Region

Private Bag X15, Stutterheim 4930

Dr P.J.S. Pieterse: Director
Mr P.F. du Toit: Deputy Director (Research)
Dr D.M. Rix: Deputy Director (Extension)

Research Station - Dohne (Stutterheim) (central research station) and Bathurst (Port Alfred)

A number of experiments are also carried out at East London.

Free State Region

Glen College of Agriculture, Private Bag X01, Glen 9360

Mr T.E. Skinner: Director
Dr N.J. Robbertse: Deputy Director (Extension)
Dr E.A.N. Engels: Deputy Director (Research)

Research Stations/Experiment Farms - Glen (central research station), Armoedsvlakte (Vryburg), Koopmansfontein (Barkley West), Rietrivier (Herbert), Sandvet, Upington complex and Vaalharts (Jan Kempdorp).

Highveld Region

Private Bag X804, Potchefstroom 2520

Dr J.D. Slabber: Director
Dr J.E. van Niekerk: Deputy Director (Research)
Dr J.J. Coetzee: Deputy Director (Extension)
Potchefstroom College of Agriculture

Research Stations/Experiment Farms - Potchefstroom complex (central research station), Bethlehem and Swartland (Ventersdorp) (gousiekte research).

Karoo Region

Grootfontein College of Agriculture,
Private Bag X529, Middelburg, C.P. 5900

Dr H.S. Hofmeyr: Director
Dr A.J. Siepker: Deputy Director (Extension)
Mr H. Steynberg: Deputy Director (Research)
Grootfontein College of Agriculture

Research Stations/Experiment Farms - Grootfontein, Middelburg, C.P. (central research station), Carnarvon, Tarka Conservation Area, Hales Flats and Jansenville.

Natal Region

Private Bag X9059, Pietermaritzburg 3200

Dr C.N. MacVicar: Director
Mr S.D. le Roux: Deputy Director (Extension)
Dr C.F. Sievers: Deputy Director (Research) Cedara College of Agriculture

Research Stations/Experiment Farms - Cedara (central research station), Drakensberg complex (Estcourt), Northern Natal (Dundee), Kokstad and Pongolapoort (Makatini).

Transvaal Region

Agrivaal Building, c/o Edmund and Hamilton Streets, Private Bag X180, Pretoria 0001

Dr A.D. Venter: Director
Mr F.F.M. van Aswegen: Deputy Director (Extension)
Dr M.K.S.L. von la Chevallerie: Deputy Director (Research)

Research Station/Experiment Farms -

Roodeplaat (central research station), Soutpan
(Pretoria), Athole (Amsterdam), Loskop
(Groblersdal), Mara (Louis Trichardt), Messina,
Nooitgedacht (Ermelo) and Towoomba
(Warmbaths).

Winter Rainfall Region

Private Bag, Elsenburg 7607

Dr J. de V. Burger: Director
Mr A.F. Kriel: Deputy Director (Extension)
Elsenburg College of Agriculture
Mr M.C. Walters: Deputy Director (Research)
Research Station/Experiment Farms -
Elsenburg, Mariendal (Stellenbosch), Langgewens
(Moorreesburg), Nortier (Lambert's Bay),
Oudtshoorn Outeniqua (George), Tygerhoek
(Riviersonderend) and the Worcester Veld Reserve.

